JUN 19 1922

Entered as Second-class matter at the Post Office at Philadelphia, Pa., under the Act of March 3, 1879.

AMERICAN JOURNAL OF PHARMACY

A RECORD OF THE PROGRESS OF PHARMACY AND THE ALLIED SCIENCES

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Price $3.00 per Annum in Advance. Foreign Postage, 25 Cents Extra.
Single Numbers, 30 Cents. Back Numbers, 50 Cents.

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917. Authorized February 14, 1920.

PUBLISHED MONTHLY BY THE

PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE

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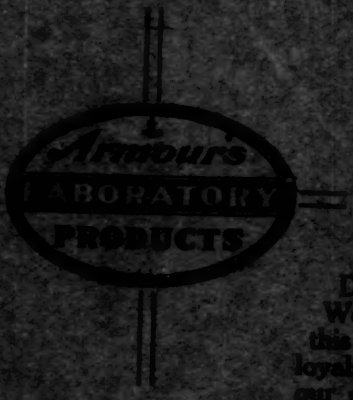

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THE AMERICAN
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VOL. 94. JUNE, 1922. NO. 6.

EDITORIAL

THE PROBLEM OF AN INTERNATIONAL LANGUAGE

Considerable attention has been given lately by the learned societies in France and Italy, and even in England, to the possibility of establishing an international language. The mixture of nations brought about by the great war, and the numerous "conferences" that have been trying to settle the issues, have emphasized the advantage of some method of intercommunication other than multiplied translations. For many centuries the learned men of Europe had a satisfactory means of communication, inasmuch as they were all trained in Latin. Today, pharmacists are about the only class that still employ this language regularly. The first edition of the U. S. P. (1820) was bilingual, the Latin and English appearing on alternate pages. There is little hope that the universality of Latin will be restored. It is a very difficult language, both as to grammar and syntax, and the attention of those who are promoting the adoption of an international tongue is directed to either the development of an artificial one, or the adoption of some existing language. The latter plan is generally regarded as impracticable, national jealousies being too strong. For many years French has been the language of diplomatic affairs, but has lost a little of late, owing to the extension of English. Of the "Big Four," who controlled matters at Versailles, three spoke English, and the fourth, the Italian representative, had an excellent interpreter. Frenchmen, indeed, have had some qualms as to the future of their language in diplomatic circles.

As regards artificial languages, it is to be noted that many have been constructed, but none has obtained any extensive recognition. Esperanto has been most successful, and is looked on with some favor by the promoters of an international tongue. A few serious defects in it have led to suggestions of improvement, and the

amended tongue has been called "Ido." Esperantists generally have been anything but indulgent towards the reformers. A troublesome feature of Esperanto is the accented letters. It is a great bother to be obliged to place such accents. French is very trying in this respect.

It is a serious question whether any artificial language so far offered will serve the purpose intended. Several objections attach to any such scheme. In the first place, the study of an artificial language opens no new literature. All its texts are translations from other tongues. Secondly, it is a question whether the numerous idioms in the spoken tongues will not be carried into translations and give rise to confusions. An instance of the difficulty of dealing with idiomatic expressions occurred lately. Mr. Wells wrote a story entitled "Mr. Brittling Sees It Through." It was intended as a promoter of *morale*, and was naturally translated into French, but the translator misunderstood the phrase, and his title means "Mr. Brittling Sees Through It." The construction of an international tongue must be carried out with great care, and especially the verb-forms must be thoroughly analyzed so that the expressions may be constructed upon the exact significance desired, and not, as is often done, by a crude analogy with the verb-forms of the language from which the translation is made. Thus, in German, the subjunctive is commonly used in reporting the words of another person; in French the same mood almost invariably follows "que." Neither of these forms is fundamentally important, and the artificial tongue must eliminate both so well that a German or a Frenchman cannot fall into the error of repeating idioms of the respective languages. Esperanto has an accusative case used after verbs of motion. This is wholly unnecessary. Four great languages, French, Spanish, Italian and English, operate perfectly well without any distinction between the nominative and objective, except as to pronouns. Esperanto nouns all end in "o" and are, of course, all without distinction of gender, but the opening line of the Esperanto anthem,

"En la mondon venas nova sento"

requires the accusative form, because it means "into the world comes new thought."

The problem of a written language for world use is difficult enough, but that of a spoken one is far more difficult. There are marked and very peculiar differences in the pronunciations of the

great languages of western Europe. German has the palatal "ch," and the umlauted vowels; French has the nasalized syllables; English has the two "th" sounds. Spanish-speaking persons find it very difficult to pronounce a combination of "s" with another consonant—such as "st," "sp"—without uttering an "e" first, so that in beginning to speak English, Spaniards generally say "estreet" and "estand." English has in several respects great advantage, such as its almost entire lack of formal grammar, especially the absence of distinctions of gender in its nouns and adjectives and the simplicity of its verb-forms, but the outrageous confusion of its spelling constitutes a serious practical objection. Spanish is probably the most suitable of the modern tongues for international use. Its pronunciation is as nearly phonetic as a living language can be, its grammar is simpler than that of most of the languages of Continental Europe, and it is melodious. Curiously it has the sibilant "th" and a palatal sound analogous to the German "ch." Italian is also a closely phonetic tongue, but it is not likely that the language of any nation competing in the world struggle will be adopted for international purposes. Spain is out of this race and, therefore, her language might have a chance.

Undoubtedly great benefit will follow the adoption of some method of communication between scientists that will relieve them from the necessity of studying several languages, but the problem is an extremely difficult one and does not seem to be appreciably near solution. Between Esperanto and Ido, the latter seems to be preferable. H. L.

ORIGINAL PAPERS

THE RAW MATERIALS OF THE CHEMICAL INDUSTRY.*

By Prof. Samuel P. Sadtler, Ph.D., LL.D.

(Professor Emeritus of Chemistry, Philadelphia College of Pharmacy and Science.)

The function of the chemist is not purely, or even mainly, to determine the composition of matter. There was a time in the past when the analytical side of chemistry was made of chief importance,

*One of a series of Popular Lectures delivered at the Philadelphia College of Pharmacy and Science.

but this was in the beginning of the science. The French chemist, Lavoisier, who may be said to have established modern chemistry on its exact foundation, in 1793 defined chemistry as "the science of analysis." And there is no doubt but what this side of the subject was, for a long time, the main pursuit of chemists.

This, in a sense, was a necessary and a natural course, because until the methods of analysis had improved, we could have known very little of the chemical elements, and we would not have been in a position to talk of a chemical industry built up on definite foundations.

However, by the middle of the last century already, the definition, before referred to, was modified, and the French chemist, Berthelot, defined chemistry as "the science of analysis and synthesis." And since that time chemistry has accomplished its chief results in the field of synthesis.

Great chemical industries, therefore, have only developed in this latter period of time, because until synthetic work could be brought to supplement the work of analysis, such industries were impossible. The great coal tar industry may be said to have been founded in 1856 with the discovery of the first aniline dye color, yet the substances, benzene, aniline, phenol, etc., had been identified by skillful, analytical methods prior to that time.

A chemical industry, therefore, is, in the special sense of the word, a creative industry. It builds up from crude material found in nature, or from definite simple substances extracted by analytical methods, valuable products available for a multitude of uses in our daily life.

I have taken as my subject "THE RAW MATERIALS OF THE CHEMICAL INDUSTRY." The successful development and establishment of the chemical industry is primarily based upon the supply of cheap and satisfactory raw materials. We will review, therefore, some of the more important industries based upon the utilization of inorganic and organic raw materials, and consider how we are situated for the development of these industries in this country by reason of our possession of suitable raw materials.

The first raw material in any manufacturing industry, the possession of which in sufficient amount, and at satisfactory price, is essential, is fuel of some kind. We will, therefore, take up first the subject of fuels, and note the position which the United States oc-

cupies in its possession of this important primary essential for successful chemical manufacturing. We may review briefly the case of solid, liquid and gaseous fuels, and note the situation with respect to each of these.

The solid fuel found most abundantly in nature, and most valuable, is coal. The United States possesses practically all grades of this essential fuel, namely anthracite and bituminous coals and lignite naturally occurring; and from these is able to manufacture the modified fuel, known as coke, to great advantage. As is known, the anthracite coal of Eastern United States is the most valuable deposit in the world of this high grade fuel. There are lesser deposits of the same kind of coal elsewhere in this continent, as in British Columbia, but they have not yet come into any extensive use.

Still more available, are the great deposits of bituminous coal found in almost every part of the United States, but notably east of the Mississippi River. From bituminous coal, by a process of destructive distillation, is then produced coke, which represents the fixed carbon of a bituminous coal, while the volatile matter has been driven off, either wasting it, as in the old bee-hive oven, or collecting it to great advantage, as in the modern by-product coke oven, in which hydrocarbon gases, coal tar and ammonia are all collected and in the aggregate form most valuable materials for either direct use or serving as intermediates in the production of other chemical compounds.

In the chemical industry, bituminous coal, in recent years, has been used very extensively in the form of a finely powdered coal, in which case it can be used to great advantage by burning it mixed with a current of air from jets, whereby the maximum heat of combustion is realized. This may be said to have begun in the cement industry, where the rotary kilns are heated by this mixture of powdered coal burning with a current of air, but the use of the solid coal in powdered form has been extended quite widely. It is stated, for instance, in 1919, from ten to twelve thousand tons of bituminous coal were pulverized for industrial use. Of this, about six thousand tons were used in the Portland cement industry, and two thousand tons in the iron and steel industry. This method of using fuel developed in the United States, and has become more widespread with us than in any other country, although it has been introduced more recently also in England, France and Japan.

Coke is used directly as solid fuel in very many metallurgical industries, particularly where the reducing action of carbon is desired in chemical operations. Modifications of the use of coke in recent years are found in the briquetting of it with pitch, etc., and in the mixing of it with fuel oil, whereby the fine coke is used to great advantage.

Under liquid fuels we have the most important substance, called petroleum, which has become increasingly valuable and necessary as an element in industry, as well as in every-day life. Looked at from the standpoint of the chemical industry, petroleum is most generally utilized in the form of fuel oil, representing a heavy end of the petroleum distillation from which already the gasoline and the kerosene have been driven off.

Fuel oil, or thick oil residuum, is of the greatest value because of the completeness with which its combustion can be effected in practical use. Not only that, but it is also a highly condensed hydrocarbon mixture of the highest fuel value. The B. T. U., or British Thermal Unit Value, of a fuel oil will, for instance, stand as high as eighteen thousand B. T. U.'s per pound; whereas, thirteen to fourteen thousand would be a value for a good bituminous coal, and perhaps twelve thousand for an anthracite, when the ash necessarily reduces the value per unit of weight. Besides the burning of fuel oil direct, the burning of it in Diesel engines is becoming more widespread as a direct source of power.

The abundance of this liquid fuel or petroleum in the United States is a great advantage for our chemical industry. At the present time, the United States produces slightly more than two-thirds of the world's annual petroleum supply, and with the addition of the supply from Mexico, which is very easily available for us, we have a great advantage over any other part of the world in this matter of fuel.

If we turn to gaseous fuels, we find similarly a very satisfactory case in the fact that in the United States we have natural gas, which is generally over 90 per cent. pure hydrocarbons, very abundantly occurring, associated with the petroleum production. This is, of course, a still more perfect fuel even than the liquid fuel, because of the perfection with which the combustion is effected.

In many industries, artificial gaseous fuel is used, namely producer gas, where a natural gas is not available. Of course, pro-

ducer gas, made by blowing air through highly heated fuel, and producing a mixture of carbon monoxide and nitrogen, is of much lower fuel value than the natural gas, but still it is a cheap and convenient form of fuel. This is available where the different kinds of coal are had as the starting point in its manufacture.

To sum up, American chemical industries are most favorably situated with regard to the fuel supply. And with any reasonable care in the utilization of this raw material, they have a great advantage in operation.

In connection with this survey of fuels considered as the basic raw material for chemical industries, it is worth while noting that many chemical industries are developing in countries in which the natural fuels above enumerated are almost entirely wanting. This is by reason of the development of what are called hydro-electric power installations. Countries like Norway, Switzerland and Italy, in which coal deposits are almost entirely wanting are yet successfully developing chemical and other manufacturing industries by reason of their available water-power resources.

If we ask the question as to how this country is situated for such development, we find that conditions are potentially favorable, in that we have abundance of water-power readily available, and a very considerable beginning has already been made in this line. And where such a development has been made, chemical industries have promptly located in considerable degree to the exclusion of other applications for the newly developed water-power. We need only refer to the large developments of the chemical industries at Niagara Falls, Sault Ste. Marie, Mich., and in the State of Maine. Some references to these will be made later in speaking of individual chemical industries.

ACID AND ALKALI MANUFACTURE.

As basic chemical industries underlying many secondary developments in manufacturing are the industries of the important mineral acids—sulphuric, nitric and hydrochloric; and of the alkalies, such as sodium carbonate and caustic soda and potash.

It has well been said that sulphuric acid is to the general chemical industry what the manufacture of iron is in the metallurgical field. The manufacture of sulphuric acid has grown steadily, of course being very greatly increased by the demands for the manu-

facture of ammunition and war products in recent years. It was stated in January, 1921, that the present manufacture of sulphuric acid in the United States amounted to about six million tons, calculated to 50° Be. strength. While this shows the result of war stimulation as before remarked, it is very probable that the amounts demanded in the immediate future will not fall much below this, as with the return of industrial activity the great demands for sulphuric acid will continue. We need only recall that the manufacture of phosphate fertilizers is entirely dependent upon the use of sulphuric acid to decompose the natural phosphates, and it is estimated that half the production of sulphuric acid in normal times goes into this utilization.

Somewhat less in amount, but still a very large consumer of sulphuric acid, is the petroleum refining industry. But there is hardly a chemical industry that can be considered that does not call for sulphuric acid as one of its most important reagents.

Now the raw materials for the sulphuric acid manufacture are primarily sulphur; and secondarily nitrates, either natural or artificial.

The first of these raw materials can be had either in the form of native sulphur, or by the roasting of pyrites to produce the sulphur dioxide needed in the reaction for sulphuric acid manufacture. As long as the sources of supply of native sulphur were the Sicilian sulphur imported into the United States, it was considered cheaper to utilize pyrites. This pyrites was in part brought by importation from Spanish mines, and in part was native pyrites of which we have numerous large deposits, notably in the State of Virginia. But these conditions of supply have been practically completely changed in recent years.

There was discovered a few years ago a large deposit of native sulphur in Louisiana, which, although occurring at a considerable depth below the surface, was made available by the introduction of the Frasch process, whereby the sulphur is melted by forcing heated water under pressure down through the annular space of the tubing of the well, and forcing the melted sulphur, under pressure, through a central tube so that it is delivered at the surface in a continuous stream in the molten state. This was very successfully developed by the Union Sulphur Company, and speedily had its effect upon the

price of crude sulphur, and upon the figures of importation of sulphur into the United States.

This discovery in Louisiana was followed by the discovery in the adjacent sections of Texas of similar deposits, which are worked in exactly the same way and have speedily added enormous production to that begun by the Union Sulphur Company. These were the Freeport Sulphur Company and the Texas Gulf Refining Company. Developing rapidly, the present domestic production of sulphur from these several sources now amounts, according to Dr. R. F. Bacon, of the Mellon Institute, to one million tons annually, and with the possibility of increase, if demand arises, to several times that much. Moreover, this sulphur is of high purity, being distinctly superior to the Sicilian sulphur in that respect, being guaranteed as 99.9 per cent. sulphur.

Dr. Bacon calls attention to the development of this American source of supply, and cites the following striking illustration of the same. In 1900 all but 5 per cent. of the world's supply of native sulphur came from Sicily, while in 1917, 80 per cent. of the world's supply of sulphur came from the United States.

As to the secondary raw material needed for the sulphuric acid manufacture, above mentioned, namely nitrates, this of course applies only to the manufacture of sulphuric acid by the Chamber Process. With the Contact Process, which is increasing steadily relatively to the older Chamber Process, we have only the sulphur to consider as a fundamental raw material. We will refer to the nitrate raw supply now in speaking of nitric acid, the second of the important mineral acids.

Nitric acid is second in importance only to sulphuric, and during the late war there was an abnormal demand for nitric acid as the material for the production of high explosives. This will be seen from the citation of a few figures. In 1914, the American production of nitric acid was 79,000 tons; in 1917, this rose to 404,000 tons; and in 1918, to 634,000 tons; but in 1921, the production had dropped to slightly above the 1914 figures.

So far, the chief raw material for the production of nitric acid in the United States has been the sodium nitrate imported under the name of Chile salt-petre. We have heard much of nitrogen fixation and the necessities for successful development of such a process as a means of supplying us both with nitric acid for the arts and for

explosives and of ammonia for fertilizer manufacture; but the fixation of nitrogen from the atmospheric air can hardly be said to have been begun commercially as yet in the United States.

It is true that during the war, under the insistent demand for nitric acid for high explosives, the DuPont Company installed the Birkeland-Eyde electric furnaces for the manufacture of nitrogen oxide direct from the air, but this process requires cheap electrical energy, which, though readily available in Norway, is not as yet available in sufficient degree to make it commercial in this country.

On the other hand, the fixation of nitrogen to form ammonia has been done in this country, similarly under war pressure, by the Cyanamid Company (to be referred to later), and by the General Chemical Company, using a modification of the Haber Process. This process, or a modification of the same, is now being operated by the Solvay Company at Syracuse, New York, who are affiliated with the General Chemical Company, and are using their improvements of the Haber Process, which were developed during the war. Whether we will have, in the near future, the production on a much larger scale of ammonia by atmospheric nitrogen production at Muscle Shoals, Alabama, will depend upon the slow negotiations which are now going on between Congress and Henry Ford and others, who are planning to take up this manufacture on a large scale.

Of course, in speaking of ammonia, it must be borne in mind that ammonia is readily oxidizable to nitric acid, and may be considered as a step in the manufacture of nitric acid, if desired.

The third of the important mineral acids is hydrochloric acid. This was formerly made, and is still to some extent, by the action of sulphuric acid upon salt. In this country, the development of the manufacture of electrolytic hydrochloric acid by the electrolysis of salt solutions has established itself in a very satisfactory way at Niagara Falls, and the future production of hydrochloric acid will be largely electrolytic. In either case, the fundamental raw material is salt.

The United States is very favorably situated for the production of this raw material. The salt industries have long been established in New York State, in Western Pennsylvania, and in Ohio and West Virginia, but at the present time the chief salt producing locality in the United States is the eastern section of Michigan. Very pure beds of salt from 100 to 400 feet in thickness are worked for the produc-

tion of brines from the same. An interesting observation also is that these Michigan brines at a depth of about 700 feet contain bromides, and hence serve as the American source of bromine. But at 1600 feet depth, we have a stratum of extremely pure salt free from bromides, and yielding the purest refined salt as its product.

There are many localities throughout the United States where salt is available, not only by working of salt wells for the production of brine, but where compact beds of very pure rock salt are found as a product of ordinary mining.

The most important alkali manufactured on a large scale is soda. We distinguish here between sodium carbonate (soda ash) and caustic soda (sodium hydroxide). The raw material in both cases is again salt, or brine. The older process of manufacture of soda ash, known as the Leblanc process, was never established in this country, but the Solvay process, or so-called ammonia-soda process, has been operating very successfully for many years as an affiliated company with the original Solvay Company of Belgium.

The raw material for their manufacture is salt in the form of brines, which are produced in the neighborhood of Syracuse, New York, where the Solvay Process Company has its plant. Several other alkali companies, working by the same general method, and utilizing brines, are located in Michigan along the Detroit River.

In addition to this production of sodium carbonate may be mentioned also the process worked by the Pennsylvania Salt Company, taking cryolite as raw material. This mineral (a double fluoride of sodium and aluminum) is brought from Greenland, the only locality in which it is found in quantity.

Besides the artificial production of sodium carbonate there has developed in recent years the production of natural sodium carbonate from alkali lakes, or alkali deposits in the far West. Two of these localities have been commercially developed, both in the State of California, namely Owens Lake in Inyo County and Searles Lake in San Bernardino County.

At Owens Lake there are three companies now producing natural sodium carbonate or soda-ash, the problem being mainly the concentration of the natural alkali water of the lake, and the crystallization therefrom of the sodium carbonate. By fractional precipitation, it is separated from the accompanying salts which are found in smaller amount.

At Searles Lake, on the other hand, the concentrated brine is a solution containing predominately sodium and potassium chlorides, with smaller amounts of sodium carbonate and sodium borate. There are four companies operating here, the most important being the American Trona Corporation, and the Solvay Process Company.

There are other natural lakes and solid deposits of alkali, in the Western States, but none of them, as yet, producing any quantity of sodium carbonate, the Nebraska Lakes being worked particularly for potassium salts.

Caustic soda is produced by a modification of the procedure in working the ammonia-soda process, but increasing amounts of caustic soda, and probably the great bulk now is made by electrolytic methods. Here, of course, brine is the raw material. Not only is this carried out on a large scale at Niagara Falls, but very many chemical plants, notably the paper and pulp mills have their own extensive installations of electrolytic soda-producing cells. With brine available as a cheap, raw material, therefore, the manufacture of both sodium carbonate and caustic soda have become flourishing industries.

LIME AND MAGNESIA PRODUCTS.

A number of industries in which chemical reactions are involved require the use of large amounts of lime and, in a similar way, but in a smaller degree, the use of magnesia, besides the use of lime in the mortar and cement industry, and of magnesia in the manufacture of refractory furnace brick and similar products.

Of those minerals furnishing lime as raw material may be noted: the carbonate of lime, or limestone, which by burning yields quick lime and caustic lime; and calcium sulphate or gypsum, which, on heating yields plaster. These raw materials are obviously then of vital importance in many industries. They are abundantly found in many parts of the United States, and in consequence the industries of burning lime and preparing lime for utilization in chemical industries have been very extensively developed.

The use of lime in the ammonia-soda process may be taken as an illustration of its value as a chemical reagent, and the use of limestone as a flux in the iron blast-furnace process may be taken as an illustration of the use of the same raw material on a large scale.

The manufacture of all grades of cement, and notably of Port-

land cements, have also developed enormously in the United States, and here the mixtures of limestone and clays are the necessary raw materials.

Another chemical industry of large development is the manufacture of bleaching powder, and bleaching solutions, for which lime, and, in the case of the sulphite paper process, magnesia are necessary raw materials to be converted into the finished products, either calcium hypochlorite or calcium and magnesium bisulphite, respectively.

Still another very important chemical industry in which lime enters as a necessary raw material is the manufacture of calcium carbide. This is a high temperature electric furnace product using limestone and coke as the raw materials which react at the high temperature of the electric arc to produce the compound of calcium and carbon. This latter is valuable in two ways. It reacts with water to liberate acetylene gas, which is of great value as an illuminant in acetylene lamps, and also has come into extensive use in the process of acetylene welding, developing with oxygen an enormously high temperature by the aid of which the welding of heavy metal castings and forgings, etc., is easily effected. And then again, calcium carbide is needed as a step in the manufacture of calcium cyanamid which is coming into extensive use as a basis of fertilizer mixtures. The carbide industry is extensively developed at Sault Ste. Marie, and the cyanamid industry at Niagara Falls.

The mineral magnesite, or native magnesium carbonate, has become of great value in recent years as a raw material in the manufacture of furnace brick linings of high refractory quality for the steel companies. The purest magnesite needed for this purpose was brought for a considerable time from Greece and Asia Minor. It is now, however, produced very extensively in the two States of California and Washington. The production in these States in 1920 amounted to 303,000 tons, while importations of magnesite amounted to 43,154 tons only.

Besides magnesite, another raw material is the double carbonate of lime and magnesia known as dolomite. This serves as a valuable source for the magnesia products used in the magnesia insulation industry which has developed very extensively in this country, the products of which having found a multitude of uses.

ALUMINUM AND CLAY INDUSTRIES.

Clay is essentially a silicate of aluminum. The extraction of the metal from clay is, however, not so readily practicable so that this cheapest of raw materials is not available for the production of the metal. However, there occurs in large deposits a mineral which is a hydrated aluminum oxide, under the name of bauxite.

This is the present source for the production of metallic aluminum. From the crude bauxite is first extracted the pure aluminum oxide, and this by the Hall process is dissolved in melted cryolite and directly electrolyzed for the production of the metal.

The bauxite was first obtained from France, but later it was found that we had abundant deposits in the States of Alabama, Georgia and Arkansas, from which sources a half a million tons of bauxite are now produced.

Not only is bauxite the raw material for the production of the metal, but it is found that bauxite simply fused in the electric furnace makes a better abrasive than the natural emery or corundum, and it is now sold for this purpose under a variety of names, such as "aloxite," "alundum," "exolon," "lionite" or "coralox." The alundum refractory-ware used by chemists is made from the fused bauxite by working it up with bonding materials into crucibles, muffles, and other forms, and baking these in a kiln. The product is porous and not attacked by acids, and therefore of the greatest value for filtration in chemical operations.

While the first artificial abrasive that came into extensive use was carborundum, or silicon carbide, these newer abrasives made from bauxite have found a more extensive development, the present manufacture in this country of the aluminum abrasives being as about eight to one in comparison with the carborundum production.

Metallic aluminum, as made by the Hall process, has proven to be a very valuable metal for a great variety of uses, because of its extreme lightness, and other valuable qualities. It also forms a series of very valuable alloys with copper, known as aluminum bronzes, which are used for a great variety of purposes.

The most valuable chemical salt of aluminum is aluminum sulphate, which is used as such, or when crystallized with an alkaline sulphate as alum. The extensive uses of aluminum sulphate in the manufacture of sizes for paper and for the clarifying of water are

of course well known. It is also well known as an astringent in medicine. The aluminum silicates or clays form the basis of a great variety of industries. Clay is the basis of the pottery and ceramic industries, which are extensively developed in all parts of the United States, notably in the States of Ohio and New Jersey. All of the raw materials for these lines of manufacture are now available from domestic sources, although certain clays considered necessary were imported until the beginning of the late war.

Another use for clays is in filtration. While natural clay filtration for waters is a very old and well-known illustration of this, it has only been in relatively recent years that the use of special clays, such as fuller's earth, have come into extensive use for oil filtration. Very important in this connection, is the colloid character of the clay, because particularly these clarifying effects in filtration are due to the phenomena of adsorption of colloid surfaces.

The chemist has come to make extensive use in manufacturing operations of chemical stoneware. This industry had developed very greatly in the United States during the recent war period. Acid-proof stoneware, for the manufacture of nitric and hydrochloric acids, for use in electrolytic cells, battery jars, nitrating kettles and autoclaves, are all illustrations of this development. The American chemical stoneware, utilizing domestic raw materials, has had a wonderful development.

The total value of all ceramic products made in the United States in 1918, according to the Bureau of Mines, amounted to about $447,000,000. Of this sum $222,000,000, or nearly one-half, represented clay products, the balance being glass or other silicate production not involving clay. Of the clay products 76 per cent. covered brick, tile and other structural materials, and 24 per cent. of the finer wares classed as pottery.

SILICA AND CLAYS.

An extensive line of industries are based upon the utilization of silica. In the form of sand or crushed rock, we have here the production of fusible silicates of alkali and lime with other metallic oxides known by the collective name of glass. If an alkaline silicate alone is manufactured with no addition of other base, we have what is known as water-glass or soluble glass. The uses of water-glass have developed very greatly in recent years, and its manufacture has responded to the widespread demand for the water-glass.

The raw material for the manufacture of glass, namely silica, is found very abundantly in very satisfactory quantity in all parts of the United States, because of the large sand-stone and quartz formations.

Another silicon compound to which reference was previously made is silicon carbide, known commonly as carborundum. This was discovered in 1891 by Acheson, and represented a product of high temperature electric furnace action, the raw materials being clay, carbon in the form of coke, saw-dust to make the mass porous, and salt to add fusibility. The resultant product, however, has the formula CSi, being a definite compound of the two elements, carbon and silicon. It is, in hardness, next to the diamond, and is superior to the native corundum or aluminum oxide, and has been very extensively used as an abrasive.

FERTILIZERS.

The three essential elements that seem to be necessary for nourishing the soil, and making it adapted for plant growth, are nitrogen, potassium and phosphorus. Of course, it is understood that these must be in some assimilable form of combination, sufficiently soluble in water to be taken up from the soil in the growth of the plant. Their fundamental importance is recognized when we are told that one ton of wheat takes away from the soil about forty-seven pounds of nitrogen, eighteen pounds of phosphoric acid, and twelve pounds of potash.

These essential materials have been added in crude form even by those practicing the most primitive methods of farming and long before the days of the development of scientific agriculture, and an understanding of soil fertility. For instance, the use of wood ashes, practiced from the earliest historic times, supplied the potash, and animal manure supplies the nitrate and the phosphoric acid.

However, in the development of scientific agriculture, we have come to recognize the necessity of a fertilizer industry, specially developed with reference to the understanding of agriculture. The chief raw material for the supply of the phosphoric acid is the naturally occurring phosphate rock, which is an insoluble calcium phosphate. This raw material is one of the most abundant and readily available materials in the United States. The States of Florida,

South Carolina and Tennessee, in the east, and Montana, Idaho, Wyoming and Utah, in the west, are all either present or prospective phosphate producing localities. Of course, it is not to be forgotten that the insoluble calcium phosphate must be converted into a soluble form before it can be assimilated by the soil waters, and this is done by converting the neutral phosphate into an acid phosphate or superphosphate by the action of sulphuric acid.

The phosphate industry, therefore, is distinctly an American industry because of this abundant supply of raw material, the only other readily available source, even for European supply being the Algerian phosphate deposits.

The nitrogen supply for fertilizer purposes may take various forms. In addition to the nitrogen-fixing bacteria found on leguminous plants and hence forming a somewhat limited naturally occurring nitrogen supply, we have nitrogen in the form of nitrates, ammonia salts, and the artificial product before mentioned, cyanamid.

In a previous statement, under the subject of nitric acid, I have already referred to the sources of nitric acid, namely the Chilean salt-petre or sodium nitrate found naturally and nitric acid produced synthetically by the oxidation of ammonia. We have a very limited supply of natural nitrates, chiefly potassium nitrate, or native salt-petre, in the dry districts of Nevada and Southern California. These, however, are not as yet sufficiently accessible or rich enough to make them immediately available in comparison with the Chile salt-petre. We are, therefore, mainly dependent upon this source of supply for the nitrate fertilizer ingredient in our manufacture of agricultural fertilizers, the amount so imported being something like a million and a half tons annually. Due to the very probable speedy exhaustion of these Chilean nitrate beds, there is every incentive to find a substitute which will probably be obtained by the application of nitrogen fixation methods.

We have, however, in ammonia salts another form of available nitrogen for fertilizers, and the production of ammonia as a by-product of the gas works, or of the coke oven distillation has been developed very greatly in recent years. This ammonia in the commercial form of ammonium sulphate goes, of course, extensively into the manufacture of fertilizers. Calcium cyanamid is a very valuable synthetic product made from calcium carbide, to which reference has already been made, by heating it to about 2000° F., and passing

pure nitrogen into the heated mass. It is absorbed by the carbide with the production of calcium cyanamid. Calcium cyanamid treated with superheated steam yields ammonia, or more slowly in the presence of moisture decomposes, producing ammonia and calcium carbonate, both of which are desirable under conditions for the soil. The manufacture of cyanamid mixtures for fertilizer use, therefore, has developed very greatly in recent years.

The third element to which reference was before made as essential for fertilizer material is potash. While potash is an abundant element in numerous minerals which are widely distributed, it is there locked up in insoluble form, and must be liberated and made soluble. On the other hand, there are a few soluble salts of potash available; one of these is the carbonate produced in the burning of wood, and hence found in wood ashes, to which reference has been made. This, however, would be a very inadequate source of supply, as the use of wood as a fuel has passed out of present practice.

Other soluble salts are the chloride and the sulphate. These are found as originally deposited by the evaporation of sea water in the so-called potash salt deposits of Stassfurt in North Germany and of Alsace, but unfortunately not as yet in satisfactory or corresponding availability in this country.

Nevertheless, under the conditions which prevailed during the late war, when the supply of German potash salts was cut off, very assiduous search was made for American sources of supply for these soluble potash salts. The chloride has been found in a number of our western saline lake deposits, but never in as pure a state, or segregated as distinctly as in the Stassfurt occurrence. For instance, the raw brine of Searles Lake in San Bernardino County, California, contains about 5 per cent. of potassium chloride. The same brine, however, contains about 16½ per cent. of sodium chloride, about 7 per cent. of sodium sulphate, nearly 5 per cent. of sodium carbonate and 1½ per cent. of sodium borate. Therefore, the extraction of potassium chloride in a sufficiently pure form from this salt admixture involves the practice of fractional precipitation, and very careful working to eliminate these other salts, and particularly the borate, any quantity of which is claimed to be injurious for the potash in any fertilizer application. The American Trona Corporation produces a potassium chloride from 90 to 95 per cent. pure, containing only traces of borax.

At Salduro, Utah, there is also a potassium product from brines not quite so complex, and involving only the separation of potassium and sodium chlorides, which is not so difficult to effect. In Nebraska are numerous salt lakes and marshes containing mixed potash and sodium salts. From these considerable quantities of potassium salts have been obtained.

At Marysville, Utah, is found an extensive deposit of the mineral, alunite, or natural potash alum. This is worked for potassium suphate by a process of roasting and leaching.

In considering our American sources of potash salts, we must not overlook the fact that has been shown that in the manufacture of Portland cement, the flue dust frequently contains notable quantities of soluble potassium salts. These have arisen from the presence of potash in the shales used for cement manufacture. Successful efforts have already been made to wash the flue dust, and to practice electrical precipitation by the Cottrell process for the recovery of these potash salts. The total amount so obtainable would be very great, but as yet not much has been extracted from this source. Of the insoluble potash minerals which have been considered as sources of potash salts, following a treatment or opening up of the insoluble mineral, may be mentioned feldspar, leucite and the green sand of eastern New Jersey. None of these, however, have as yet produced successfully any large quantities of potash salts.

METALLURGICAL INDUSTRIES.

The extraction of metals from their ores, and the treatment of the metals so extracted to give them desirable qualities, whether by alloying them with each other, or by various kinds of heat treatment is of course a branch of chemical industry. America has taken a very advanced position in this branch of chemical industry, and in some cases has been the pioneer in the developement of useful metals and products from the same.

It is not necessary for us to refer to the fact that the United States is by far the largest producer of iron and steel in the world, as we have been blest with abundant supplies of raw materials of all grades. But we will refer merely to recent developments of so-called various alloys. Manganese-steel, nickel-steel, chromium-steel, tungsten-steel, vanadium-steel and molybdenum-steel, are a few of the many alloys of iron whereby special, and in some cases very

highly desirable qualities are imparted to the steel. High-speed tools, acidproof metal and stainless steel represent products of this kind in which specially desirable qualities have been attained by the production of suitable alloys.

One of the most valuable metals which, until in recent years, was referred to as a rare metal is tungsten; yet it is stated that under the urge of war demand between May and December of 1918, there was manufactured in the United States more than 45,500,000 pounds of tungsten steel containing some 8,000,000 pounds of tungsten. The ore comes from Colorado and California.

Tungsten has also developed a most important use since it has been found possible to draw it into wire, namely the manufacture of the tungsten filament for Mazda lamps.

Reference was before made to aluminum alloys, such as the aluminum bronzes. Other alloys of aluminum, however, have been developed in recent years that are specially characterized by lightness and great strength such as "magnalium" and "duralumin." Many substitutes for platinum have been developed because of the high price of platinum, and the importance of it to the chemist.

Copper is a very important element for a great variety of uses, both used as such, and in the formation of alloys like brass and bronze. The metallurgy of copper has been developed in the highest degree in the United States, and considerably more than half of the world supply of copper is now of American production. The fundamental importance of copper in the electrical industries explains the relative position of copper among the metals.

Lead and zinc are also two metals which are produced on the most extensive scale in the United States, not only because of the valuable uses of the metals themselves, and their alloys, but because of the valuable pigments that can be made from them. The manufacture of white-lead, zinc-oxide and lithopone paints have become very large industries.

Nickel is a metal which has also developed steadily until it now holds a very important position, mainly because of the valuable alloys formed from it. While the working of nickel has extensively developed in the United States, we are practically dependent upon Canadian ores for this metal, namely the two localities of Sudbury, where it occurs associated with copper, and Cobalt, Ontario, where it occurs in silver-bearing ore. The association of the nickel with

copper has led to the production of a most valuable alloy of these two metals directly obtained by reduction from the natural mixture of the ore. This is the so-called Monel metal, which has many very valuable properties, chemical and electrical.

The precious metals, particularly gold and silver, have been produced extensively in the United States, although in the case of the former, America is no longer the chief source of its production.

Lastly, we may refer to the production of the interesting metal, radium. The chief production of radium, furnishing practically the main supply of the world is from the American mineral, carnolite, found in Colorado and the extraction of the metal is almost exclusively carried out in this country.

BITUMINOUS MATERIALS.

The chemical industries based upon bituminous materials of some kind are among the most important in the whole range of chemical production. We have already referred, under the heading of fuels to the production of petroleum and natural gas, which is associated with it in nature. We will not, therefore, expand upon the subject here, although the petroleum products figure not only as fuels, but also as among the most important illuminating products, and from the heavy oils are produced lubricants which are of indispensable value in all mechanical lines.

In addition to petroleum, we may note under this heading of bitumens, the importance of asphalt. Asphalt is a chemical closely related to petroleum, and in fact, is found in many cases directly associated with it, so that many crude oils yield an abundance of asphalt left as residue after the distillation of the illuminating fractions. However, there are occurrences of asphalt in compact form independent of the liquid petroleum. The most abundant source of asphalt for the various industries, such as the asphalt paving industry, the manufacture of mastic or asphalt cement, etc., is the Island of Trinidad, in the West Indies, from whence it is brought to the United States in bulk and worked up into a variety of products by the Barber Asphalt Company, and other manufacturers.

We must not overlook the fact, however, that there has developed a very extensive manufacture of so-called artificial asphalt made from petroleum residuums by different methods of treatment, especially by blowing with a current of air at high temperatures.

A third great natural source of supply for products of this class is the oil shales. This industry is, at the present, only a prospective industry, and does not pass beyond the experimental stage, but the discovery of enormous deposits of oil-producing shales in Western Colorado and Eastern Utah, as well as smaller amounts in other States, will certainly lead in the immediate future to the development of a great industry, as this source of supply must be drawn on in the near future to furnish the oils of all classes, to take the place of petroleum, the supply of which is certainly within sight of exhaustion.

This industry has, of course, existed for a number of years in Scotland, so that while it would not be a new industry that would be developed in the United States, the differences in the American shales and the Scotch shales will, no doubt, lead to different methods of development.

VEGETABLE AND ANIMAL FATS AND OILS.

We have here an extensive class of raw materials upon which are built a number of most important chemical industries, and a large number of which have been specially developed in the United States, either because of the immediate availability of the raw materials in this country, or because of the establishment of the industries based upon these raw materials.

Thus, we have food industries, which utilize purified oils and fats on an extensive scale, the manufacture of lubricants for which some of the vegetable and animal oils are especially fitted, and which cannot be replaced by mineral oil lubricants; the manufacture of soaps, fatty acids and glycerine by the decomposition of the fats and oils, and the manufacture of paints and varnishes based upon the utilization of the class known as drying oils. This gives us a very extensive list of chemical industries, and it would be impossible within the space at our command to even make a complete enumeration of them.

Some of these raw materials are peculiarly American in their origin. We would specifically mention, first of all, cottonseed oil, which has developed in this country extensively because of its being a by-product of the cotton crop of the United States. The cottonseed oil, when purified, is not only used as such for food purposes,

but goes particularly into the manufacture of oleomargarine and lard substitutes, and as a most valuable and available soap stock.

Equally characteristic as an oil mainly produced in the United States, is corn oil. This is available, when purified, for a great variety of uses, as a paint oil, for soap stock, and particularly for the manufacture by vulcanization with sulphur chloride of a rubber substitute, which is used extensively in mixing with true rubber.

Arachis, or peanut oil, has also been developed in this country very extensively for uses almost exactly the same as those to which cottonseed oil is applied. There is a large production of linseed oil in the United States, but enormous quantities are also imported from Europe, and particularly from Argentina. The importations of linseed oil from the latter country having amounted in 1920 to a value of $69,000,000. Linseed oil, of course, is the typical paint-making oil, because of its drying properties, although used of course for many other purposes, as in soap making, etc.

A tropical oil, not produced in the United States, but of great value, partly for food purposes, and partly for soap making, is cocoanut oil. This, the United States imports mainly from the Philippine Islands, coming into the United States by way of Seattle and Pacific points. Because of the great demands for edible oils, and for oils for the manufacture of glycerine during the war, the importation into the United States showed an enormous increase, and in 1918, it is stated that the copra (dried meat of the cocoanut) purchases amounted to about one-quarter million tons, and the cocoanut oil to more than 250,000,000 pounds. This went largely into the manufacture of a form of oleomargarine or vegetable butter substitute.

Of corresponding importance are the animal fats and oils, such as butter fat, lard and lard oil, tallow and tallow oil, and the marine animal oils, such as cod liver oil, menhaden oil and sperm oil. All of these raw materials are utilized on the most extensive scale in chemical industries well established in this country.

NAVAL STORES AND RUBBER INDUSTRIES.

While the industries based upon the use of the essential oils are important and largely developed, we will not take up essential oils in any detail as a class of raw materials, but confine ourselves to the group of products known as naval stores, which include the oil of turpentine and rosin, obtained from the southern pine, the pine oils,

and pine tar, from the same general source, and briefly note also the rubber industry, which is chemically allied because of its origin, although a very different, physically appearing product.

The long-leaf pine of our southern States furnishes the well-known turpentine balsam, which, by steam distillation yields the spirits of turpentine and the accompanying solid product known as rosin. These are distinctive raw materials, although there are corresponding varieties produced in Europe from other species of pine and fir trees. Spirits of turpentine, a refined product from this production is the basis of the paint and varnish industry along with the drying oils.

In addition to the natural exudation yielding the so-called gum spirits of turpentine, there is produced, by the steam distillation of the stumps and chipped wood, a wood turpentine, which, differing slightly from the gum spirits, is, nevertheless, available, and has become extensively used in the paint industry.

In the distillation of the pine wood, whether by destructive distillation, or by steam distillation, we also have produced what are called pine oils, and pine tar, from which latter is prepared pine pitch. The production of pine oils has become an extensive industry because they have been found to be especially available as flotation oils in the extraction of copper and zinc, particularly from the ores of those metals in which the metallic sulphides are finely disseminated. The copper industry of the United States particularly has taken enormous quantities of the pine oils as an invaluable aid in the production of the metal concentrates.

Rubber is not an American production considered as a raw material, but the rubber manufacturing industry of the United States has grown enormously, and in particular because of the manufacture of vulcanized rubber clothing, boots and shoes, and in the recent years, the manufacture of automobile tires, so that the United States is the largest single consumer of crude rubber in the world. This crude rubber may be either the crude coagulated rubber from Brazil or the so-called plantation rubber obtained from the cultivated rubber trees on rubber plantations of Borneo and Java.

Rubber manufacturers, however, partly because of the rise in price of crude rubber, and partly because of competition in price, have introduced many substitutes for the true rubber. The most

important of this is probably the analogous product from the Guayule shrub or tree grown in Mexico and southern Texas, and latterly in Brazil. Artificial rubbers are also made by the vulcanization of a number of fatty oils, as was mentioned under corn oil, but these are only used as additions to the genuine rubber for cheapening purposes. Nevertheless, they constitute invariable raw materials in most large rubber works.

THE SUGAR INDUSTRY.

The extraction and refining of sugar is a great chemical industry, and one which has been very successfully developed in the United States. There are only two great sources of the raw material to consider in this connection, the sugar cane and the sugar beet. The extraction of sugar and refining of the same from the sugar cane was the earlier industry in this country, because the sugar cane had established itself successfully in Louisiana and other southern States, and in the West Indies Islands immediately adjacent.

The extraction of sugar from the sugar beet, on the other hand, was first a French, and later a German chemical industry, and it was not supposed at first that it could be established in the United States. After long-continued effort, it was found that not only could the imported seed of the sugar beet be grown satisfactorily and with a production of a sufficiently large percentage of sugar in certain parts of the United States, but within recent years it has been found that seed of American growth and production will yield sugar beets equally rich in sugar percentage.

In the case of the sugar cane, the juice must be extracted promtply, and therefore there is produced directly in the section yielding the cane a raw sugar by the use of a moderate amount of purification and evaporation to crystallization. This raw sugar, gathered from a great variety of sources is then refined to the highest grade white, crystallized sugar in the larger sugar refineries which we find in the great cities of the Atlantic seaboard, because they draw their raw sugar material from not only the South, but from the West Indies, Central American countries, Java and the Philippines.

Within recent years, the production of sugar from the sugar cane has been developed greatly in Hawaii, and these Hawaiian sugars are brought to the Pacific Coast refineries.

The cultivation of the sugar beet began in this country in California, where it took a firm hold. Later it extended to Utah and Colorado, and more recently to Michigan, in each of which States are extensive beet sugar refineries. It has been proved, however, that the sugar beet can be cultivated with care in a great many other States, and even, in recent years, it has been cultivated in Louisiana successfully.

The beet sugar industry of the United States has advanced steadily, and, of course, owing to high prices obtained during the recent war, it has grown very rapidly, and in the year 1919-20 there was produced in the United States 726,000 tons of beet sugar, which is more than the entire production of cane sugar of the United States with Hawaii thrown in. Nevertheless, the most flourishing seat of the sugar production at the present time is probably the island of Cuba, where, with American capital and American methods, the sugar crop has been developed enormously, reaching nearly 2,000,000 tons annually.

STARCH AND PRODUCTS THEREFROM.

The American starch industry is on a somewhat different basis from the starch industry of Europe, in that the chief raw material is corn or Indian maize, with wheat starch and rice starch playing a minor part; whereas, in Europe, the potato is the chief source of supply for starch.

The American starch industry, however, has developed in a very notable way, and particularly the manufacture of the products obtained by hydrolysis of starch. The glucose industry and in more recent years, the maltose industry, are peculiarly American developments, going into the manufacture of a great variety of food products, supplementing the use of corn starch in this way, besides having found a great many other technical utilizations.

In 1919, the exportations of glucose syrup amounted to 220,380,761 pounds, valued at $13,469,051, and of grape sugar (corresponding solid product to glucose) 35,236,948 pounds, valued at $1,970,893. These figures, however, represent a maximum, and they fell off appreciably in 1920.

A very interesting side industry based upon starch is the production of valuable solvents by fermentation. The Fernbach fermentation method, whereby acetone and butyl alcohol are produced

by fermentation, had already been developed prior to the war, and was used in connection with a new method for making synthetic rubber, in which butyl alcohol was a necessary raw material.

Early in the war period, however, the demand for acetone became so great, because of its value as a solvent in the manufacture of smokeless powder that this Fernbach method was taken up and developed on a large scale in Canada, using the starch of corn as the raw material. Since the close of the war, it has been further developed, and a large plant has been established by the Commercial Solvents Corporation at Terre Haute, Indiana, in the midst of the western corn belt, for carrying this out on a large scale.

One bushel of corn, by this process, is made to yield from 9½ to 10 pounds of mixed solvents composed of 60 per cent. acetone, 30 per cent. ethyl alcohol, and 10 per cent. butyl alcohol, all of which, however, are readily separable by methods of fractional distillation. This plant referred to, has a capacity of seven tons of mixed solvents per day.

At the present time, the butyl alcohol is the most desirable of the several ingredients, because of its value as a solvent in connection with the manufacture of plastics.

DAIRY INDUSTRIES.

An agricultural production may be the basis of development of extensive chemical industries, with a full understanding once attained of the chemical nature of the raw material.

We have, first of all, milk products, including condensed and evaporated milks, and milk powders, and then a variety of distinct industries based upon the utilization of certain of the constituents of the milk considered as raw material; the manufacture of butter and butter substitutes, such as oleomargarine; the manufacture of cheese, the many varieties of which depend upon the careful control of the processes of fermentation and ripening of the milk proteids; the manufacture of sugar of milk; and the production of solid casein. This latter has become a very important material as the basis of a variety of glues, adhesives and plastics, and, in this connection, entering into a great many lines of manufacturing industry as a necessary ingredient.

Without going into details, we may say that from the dairy industries, and the original milk production, have been built up a number of most important and interesting chemical industries.

CELLULOSE INDUSTRIES.

The extraction and purification of cellulose from the naturally occurring raw materials underlies a number of very important industries. We note, first, the manufacture of what is called wood pulp for paper making, noting the distinction between mechanical pulp and chemical wood pulp, under which latter head are three well-defined lines of treatment, and the production of paper-making material therefrom, namely the soda process, the sulphite process, and the so-called sulphate process.

Enormous quantities of our American trees and available forests have been already used in the wood pulp industry, and at the present time we are largely dependent upon the importation of the crude wood pulp from Canada for our continued operation of paper-making. Still large forest reserves, however, are available in Alaska, and will in the near future serve as the materials for the wood pulp industry.

Another use of cellulose is the manufacture of artificial silk, and the manufacture of films. We have here, again, several chemical processes operating side by side in furnishing the raw material, namely the nitro-cellulose process, furnishing a filament which, after denitration is a pure cellulose; the cuprammonium process in which a solution of cellulose (obtained chiefly from cotton linters) is used; and the viscose process, in which wood pulp may serve as raw material, and is converted into a solution from which filaments are spun, and a so-called acetate-cellulose filament or film.

The artificial silk industry has developed with great rapidity in recent years, and is at present established in a flourishing way, particularly with the nitro-cellulose and the viscose methods.

On the other hand, the manufacture of films is practically confined to the nitro-cellulose film, and the acetate-cellulose, the latter being non-inflammable.

The film industry has, of course, developed with enormous rapidity because of the supplementing of the demand for photographic films by the demand for films for motion picture uses. It is stated that the Eastman Kodak Company in 1920 manufactured fifty million feet of film per month, or about one hundred and twenty-five thousand miles of film per year, for motion picture purposes.

In this connection, they use nearly 3,000,000 pounds of cotton per year, as material for their film manufacture.

We also have an important chemical industry based upon these same cellulose derivatives, namely the manufacture of cellulose plastics, such as celluloid and similar materials, the chief basis so far having been nitro-cellulose, although cellulose acetate is now coming into considerable use in the manufacture of plastics because of its non-inflammable quality as compared with nitro-cellulose.

Under the heading of the cellulose industries, we must also note the wood distillation industry. Reference was made to this already under the head of naval stores, in speaking of pine oil and pine tar. But the distillation of hard woods gives us another line of products of the greatest chemical importance, such as methyl alcohol, acetic acid and minor products, such as acetone. Of course, the residue of the wood distillation yields us fixed carbon in the form of charcoal. The hard wood distillation industry is a very important one in the United States, far exceeding that of any other country.

TEXTILE INDUSTRIES.

These are based upon the utilization of both vegetable and animal fibres. The vegetable fibres, such as cotton and flax fibres, are practically composed of cellulose, or, as in the case of hemp, jute, etc., cellulose with ligno-cellulose as an alteration product. The animal fibres, such as wool and silk, on the other hand, are of more complex composition, and in particular contain nitrogen, and, in the case of wool, also sulphur.

These industries are all developed in the United States as manufacturing industries very extensively. From the standpoint of raw materials, however, there are differences to be noted. The raw material for cotton manufacturing industry is an American production primarily, as the great supply of the world's cotton industry is found in the United States.

The cultivation of cotton is not only well established in the United States, but is extending in many ways. It is stated, for instance, that 400,000 acres in the Imperial Valley of California, and in the neighboring State of Arizona have been planted with long staple cotton, and with very promising results.

The flax fibre, on the other hand, is not primarily an American product, although there is a considerable American production. The cultivation of the flax is chiefly for the seed, and the fibre for textile uses is largely of foreign importation.

The woolen industry has become very firmly established in the United States, and utilizes domestic supply of raw material as well as considerable imported material.

The silk manufacturing industry is almost entirely dependent upon raw silk imported from China and Japan.

THE TANNING INDUSTRIES.

The conversion of hides and skins into leather, and the utilization of by-products, as in the glue manufacture, have been developed from a purely empirical practice to a carefully conducted chemical manufacturing industry. The very complex and alterable character of the hide material for a long time seemed to make the adoption of exact chemical methods very difficult, but with the increasing knowlledge of the part which colloids play in these changes, more exact chemical methods can be applied.

The manufacture of vegetable tanned leather, of alum tawed and chrome tawed leather, of chamois and oil treated leather, have all been developed in a more exact chemical way year by year.

The American leather industry has taken a very prominent and creditable part in this development. The raw materials are only in part of domestic production, as the growth of the industry has made necessary the importation of heavy hides from Argentina, and goat skins from India and the East.

The vegetable tanning, originally effected with ground bark, is now in large degree effected by the use of hemlock and oak tannin extracts produced in both the United States and Canada.

Chrome tanning, which is peculiarly an American development, calls for the use of large quantities of bichromates and prepared basic chromium salts, all supplied by the American chemical trade.

The manufacture of glue has also been developed with better understanding of both the physical and chemical laws which cover the handling of colloids such as the gelatin extracted from the hide material. Similarly, the working of bone gelatin has been developed in a more exact chemical way.

COAL TAR PRODUCTS AND COAL TAR DYES.

We have read much in the last few years of the great impetus given by the war to the production in this country of coal tar products, and the founding upon them of an American dye color in-

dustry and not only the original sources of coal tar such as the gas work production are availed of, but more particularly the tar of the by-product coke oven has been produced in very largely increased amount as a result of this impetus.

In speaking of this industry, we distinguish between the immediate products of the distillation of coal tar such as benzol, toluol, phenol, naphthalene, and higher hydrocarbons. Each of these substances just mentioned may be the special material sought as a starting point of a large chemical production. For instance, the war made necessary the production of enormous quantities of toluene for the manufacture of tri-nitro toluene (T. N. T.), one of the most important of the high explosives for shells utilized in the recent war. The production of toluene had to be stimulated, but the process of manufacturing it from California petroleum, which was developed to meet the emergency, was capable of furnishing many times more than the needed amount.

The production of phenol similarly was the starting point for the manufacture of picric acid. Of course, in the case of phenol, there has been a continuously increasing demand because of the development of the class of phenol-formaldehyde plastics, such as bakelite, and the material for the manufacture of phonograph records.

What are usually referred to as intermediates are the substances which are produced from these raw materials, and then serve as the special starting points for the manufacture of specific synthetic dyes. It is rarely realized how absolutely dependent a successful artificial dye color industry is upon the use of a large number of these intermediates. This had all been successfully developed on the largest scale by Germany prior to the war, and explains why the German coal tar dyes were used to the exclusion of all other in both England and the United States prior to 1914.

At the present time, some two hundred of these indispensable intermediate compounds are manufactured by our largest American dye color firms. From these a development of a true artificial dye color industry has begun, and with such success that at the present time hundreds of dyes of quality equal to anything previously imported are now manufactured in this country, and have already established themselves quite firmly in the requirements of the textile industry.

ISOPROPYL ALCOHOL.

By DUDLEY H. GRANT, RESEARCH CHEMIST, AND CARL O. JOHNS,
Director, Research Division, Development Department, Standard Oil Co. (N. J.)

During the last two years isopropyl alcohol has become a commercial article in the United States. It is produced solely as a by-product of the petroleum and natural gas industry, and is made by absorbing olefine gases, containing propylene, in sulphuric acid and hydrolyzing the resulting alkyl sulphuric acids. The principal reaction may be represented by the following equations:

$$\underset{\text{Propylene}}{CH_3{-}CH{=}CH_2} + H_2SO_4 = \underset{\text{Isopropyl Sulphuric Acid}}{CH_3{-}CH(OSO_3H){-}CH_3}$$

$$\underset{\text{Isopropyl Sulphuric Acid}}{CH_3{-}CH(OSO_3H){-}CH_3} + H_2O = \underset{\text{Isopropyl Alcohol}}{CH_3{-}CH(OH){-}CH_3} + H_2SO_4$$

The crude alcohol is separated by distillation and purified by chemical treatment and rectification.

Physical Properties of Isopropyl Alcohol.—The rectified alcohol is obtained in the form of a constant-boiling mixture containing 91 per cent. of alcohol and 9 per cent. of water, by volume. This mixture boils at 80.4° C., and has a specific gravity of 0.819 at 15.6° C. Thus, like ethyl alcohol, isopropyl alcohol cannot be concentrated beyond a certain point by simple distillation. It is, however, much easier to dehydrate than is ethyl alcohol, a short digestion with excess of dry caustic soda and subsequent distillation giving a practically anhydrous alcohol, boiling at 82.4° C., with a specific gravity of 0.789 at 15.6° C.

The isopropyl alcohol now marketed is a colorless liquid having a somewhat bitter taste and a characteristic alcoholic odor, different from that of ethyl alcohol, but pleasant and free from the foreign odors of the crude product. It is miscible in all proportions with water but may be salted out by saturating the solution with sodium chloride or other salts or with sodium hydroxide.

Pharmacology of Isopropyl Alcohol.—The pharmacological properties of this alcohol have been studied by Dr. David I. Macht, of Johns Hopkins University, and by Professor R. Burton-Opitz of Columbia University.

Dr. Macht found[1] that, when injected intravenously into cats, isopropyl alcohol is twice as toxic as ethyl alcohol, four-fifths as toxic as normal propyl alcohol, and one-fourth as toxic as benzyl alcohol. Comparative experiments on the action of various alcohols on the isolated hearts of frogs, and on isolated plain muscle (pig's ureter) gave results indicating the same order of toxicity as that shown by intravenous injection.

Rats were exposed to air saturated with the fumes of various alcohols. Methyl alcohol killed them in one or two days, while ethyl and isopropyl alcohols, during several days' exposure, produced no apparent injury. Furthermore, no subsequent blindness or defects in vision resulted from the inhalation of isopropyl alcohol vapor, in contrast to the well-known results of methyl alcohol poisoning.

Professor Burton-Opitz performed[2] a series of varied experiments, including the following:

Fifty cc. of isopropyl alcohol was administered by mouth to a dog weighing 6.5 kilos. Symptoms of serious muscular incoordination and some gastric disturbance resulted. The dog could walk normally the next day, and recovered completely the third day. Similar results followed the administration of the alcohol by stomach tube in amounts of about 10 cc. per kilo body weight.

Isopropyl alcohol applied to open wounds in concentrations up to 50 per cent. allowed healing by what appeared to be normal granulation. Isopropyl alcohol possesses healing properties similar to those of grain alcohol, so far as this can be tested on dogs.

Small quantities of isopropyl and ethyl alcohols, in concentrations varying from 10 to 100 per cent., were injected into the jugular vein and instilled into the conjunctiva, respectively. In both cases, the effect of isopropyl alcohol was approximately the same as that of ethyl alcohol.

The experience of members of this department[3] over the last two years substantiates, so far as it goes, the findings of the investigators just mentioned. Isopropyl alcohol has been employed, from

[1] A Toxicological Study of Some Alcohols, with Especial Reference to Isomers. *Jour. Pharmacol. & Experim. Therapeutics,* XVI, 1 (August, 1920).

[2] Unpublished communication, abstracted by Grant in a paper on Isopropyl Alcohol and its Physiological Properties, from the Perfumer's Standpoint. *American Perfumer,* XVI, 334 (October, 1921).

[3] Grant, *loc. cit.*

time to time, in lotions for chapped hands or after shaving, in liniment, in liquid soap and in antiseptic solutions for the throat. It has often been used undiluted to wash the hands, to cleanse small wounds, and to dry and harden the skin of the hands when swollen by hot water and alkali. One of the writers has repeatedly taken sponge baths from head to foot in isopropyl alcohol of about 50 per cent. concentration. In no case has any injurious effect been noted.

Large samples of isopropyl alcohol have been distributed during the past year to nurses and hospitals, and used, under medical supervision, for alcohol rubs on a number of patients. No untoward effects have been reported.

In an intensive experiment carried out under the supervision of Dr. J. M. Sinclair, of the Medical Department, Standard Oil Company (N. J.), five volunteers wore bandages saturated with undiluted isopropyl alcohol covering an area of about 60 square inches on the forearm, for from three to seven hours daily for four successive days, a total of 21 hours for each man. No harmful effects, either local or systemic, were experienced.

In view of the foregoing observations, it may be concluded that isopropyl alcohol is sufficiently non-toxic to be safely employed in external and oral medication, at least.

USES OF ISOPROPYL ALCOHOL.

The general similarity of this alcohol to ethyl alcohol suggests a variety of uses, many of which have not yet been investigated, owing to the fact that isopropyl alcohol has not been made on a sufficiently large scale. These applications may be broadly divided into uses of the alcohol as such, as a solvent, and as a source of chemical derivatives.

Uses of the Alcohol as Such.—As a dehydrating agent, isopropyl alcohol will doubtless be useful in chemical and biological work and in photography. It may be used for drying nitrocellulose, sugars, starches, proteins, gelatin and animal or vegetable tissues, for dehydrating histological specimens, and for cleaning and drying photographic prints and films. A great advantage is the ease with which it may be obtained anhydrous, in contrast to ethyl alcohol.

Isopropyl alcohol is now used, in considerable quantity, as a

"key denaturant" for ethyl alcohol in Formulas 39, 39A and 40 of the United States Bureau of Internal Revenue. These are formulas for specially denatured alcohol used in perfumes and barbers' supplies, and contain certain solid substances in solution which render them impotable. The isopropyl alcohol, which boils at nearly the same temperature as ethyl alcohol, cannot be separated from it by distillation, but will remain in it if a fraudulent rectification for beverage use be attempted, and can be detected by appropriate tests.

As a surgical antiseptic, isopropyl alcohol has already proved valuable, as has been noted above. Other uses of medical interest are those as an antidote for phenol burns, as a sterilizing medium for ligatures and instruments, and as a preservative for anatomical and pathological specimens.

Uses for which isopropyl alcohol is adaptable are as a filler for thermometers, thermostats and compasses, and as an "anti-freeze" in automobile radiators.

ISOPROPYL ALCOHOL AS A SOLVENT.—In some cases, isopropyl alcohol has proved to be a superior solvent to ethyl alcohol. There is sometimes a striking difference in the solvent properties, for a given substance, of the common 91 per cent. and the anhydrous isopropyl alcohol. Perhaps the most striking difference between ethyl and isopropyl alcohols is in the relative ease with which isopropyl alcohol can be "salted out" from an aqueous solution.

Applications of this alcohol as a solvent include the following:

In the manufacture of fine organic chemicals and synthetics, for extracting pure substances from mixtures, especially from alkali fusions, or for dissolving out impurities from insoluble substances. Also as a recrystallizing solvent. Examples: Benzoic acid, salicylic acid, sodium benzoate, beta-naphthol, saccharine, acetanilid and other antipyretics, benzaldehyde, salol, benzidine, creosote carbonate, veronal, benzonaphthol, dyes, heliotropin, alkaloids, santonin, aloin, tannin, coumarin, saponins, hydroquinone, and numberless others.

In the preparation of solid medicinal extracts, plant principles, oleoresins, etc.—The official preparations must, of course, be extracted by ethyl alcohol, ether or acetone, as the case may be. There is a large field, however, for non-official products of this nature, for use in proprietary remedies, flavoring compounds, etc.

For the manufacture of such products, isopropyl alcohol has the advantage over denatured grain alcohol of containing no poisonous or offensive ingredient necessitating scrupulous elimination of the alcohol from the product before use. In cases where its solvent power is comparable, it may replace ether and acetone, thus reducing the fire hazard, as well as the loss by evaporation. Examples are: Oleoresins of capsicum, cantharides, ginger, cubeb, aspidium, vanilla, orris, labdanum, opoponax, oak moss, pepper, lupulin, etc.; agaricin, podophyllin; resin of scammony, extracts of jalap, cannabis indica, gelsemium, hydrastis, nutgalls, cola nuts, etc.

As a solvent for medicinal substances for external medication, isopropyl alcohol should be extremely useful, obviating the use of poisonous or offensive denatured alcohol, of expensive medicated alcohol and of pure ethyl alcohol which is costly and always liable to be diverted for illicit use. Non-official tinctures or spirits of the following drugs may be made by its use: Benzoin, tolu, arnica, cantharides, capsicum, pyrethrum, camphor, myrrh, larkspur, mustard, cocculus indicus, rosemary, witch hazel, etc. It should also be useful in the compounding of liniments, collodions, alcoholic lotions and antiseptic varnishes for burns and in the purification of oxgall and the extraction of lecithin, prolamines, gaduol, etc. An addition of 12 per cent of isopropyl alcohol to crystallized phenol causes liquefaction, and the resulting liquefied phenol will mix easily with both oily and aqueous liquids. Notwithstanding its slightly unpleasant taste, isopropyl alcohol is applicable to certain types of antiseptic solutions for oral and nasal use. Solutions made with it can also be used for medicating surgical dressings.

In cosmetics, the possibilities of isopropyl alcohol are considerable. As a solvent medium, it may be used in perfumes, toilet waters, bay rum, hair tonics, dandruff cures, bandolines and brilliantines, shampoo liquid or jelly, liquid rouge, and all kinds of cosmetic lotions, as well as in "theatre sprays."

In chemical, biological and medical laboratories, isopropyl alcohol is also a useful solvent. It can be used for immiscible solvent extraction from aqueous solutions or from petroleum ether solutions, being thrown out from the former by salts or alkalies and from the latter by water. It can be used for reagent solutions such as phenolphthalein, methyl orange, guaiac, phloroglucin, dimethyl glyoxime, picric acid, etc., etc., as well as for standard soap solution for water

testing and, with an addition of 20 per cent. of pure methyl alcohol, for standard alcoholic alkali. It may be used in staining solutions for bacteriological and pathological work. Its use in preserving biological specimens and in dehydrating tissues and drying precipitates has already been established.

In the nitrocellulose and cellulose acetate industry, isopropyl alcohol may serve to some extent as a "latent" solvent, or as a solvent for camphor or camphor substitutes, in the preparation of plastics, "dopes" and lacquers, films and collodion.

As a resin solvent, isopropyl alcohol will undoubtedly be useful. It is a good solvent for shellac, distinguished by the fact that it dissolves shellac wax as well as resin, giving a more viscous varnish than ethyl alcohol. It is also a good solvent for sandarac and mastic resins, for common rosin and for "bush kauri," and a useful partial solvent for elemi, copal and dammar. Its non-poisonous character gives it a great advantage over denatured ethyl alcohol in spirit varnishes which are used for food containers or which are allowed to evaporate in closed rooms where the occupants must breathe the vapors. Sanitary can lacquers, brewers' vat varnish and artists' crayon fixatif may be mentioned in this connection. Isopropyl alcohol resin solutions may eventually find use in the manufacture of transparent paper, "window" envelopes, tracing paper, stencil papers, plastic molded insulation, soldering fluxes and sealing wax, fireworks and matches and wood filler.

Other applications of isopropyl alcohol as a solvent may be briefly enumerated: In wood stains and other special dyeing; in flavoring extracts, including tobacco flavors; in the extraction of glycerine from distillery residues; in varnish and paint removers; in liquid soap; in disinfectant and deodorant solutions and insecticides; and in "dry cleaning."

Isopropyl Alcohol as a Precipitant.—An important use for isopropyl alcohol will probably be that of a precipitant for proteins and peptones, for pepsin, trypsin, pancreatin, rennin, papain and other enzymic ferments, sugars, dextrins, gums and mucilages, soluble starch, silver protein compounds, glycerophosphates, etc.

Derivatives of Isopropyl Alcohol.—The availability of isopropyl alcohol in sufficient quantity has made possible the preparation

and study of a large number of derivative compounds hitherto unknown or existing only as laboratory specimens.

Isopropyl Acetate is a fragrant liquid, boiling at 88.5-89° C. (even with very carefully purified material the boiling point of 93° given in the literature could not be confirmed). It has a specific gravity of 0.877 at 15.6° C. This ester is, as might be expected, an excellent nitrocellulose solvent, evaporating quickly, but not so quickly, it seems, as to cause the condensation of water from a moist atmosphere. It is accordingly, useful in pyroxylin lacquers.

Isopropyl Chloride is a pleasant-smelling, non-corrosive liquid with a boiling point of 36.5° C. and a specific gravity of 0.866 at 15.6° C. It is an excellent solvent of fats, and, while it can take fire, is extinguished with great ease. It can replace carbon disulphide and petroleum ether to some extent in the fat extraction industry, besides serving as an intermediate product for many synthetic compounds. It may also be used as a refrigerant in certain types of machines.

Di-isopropyl Ether is a liquid with a sweetish and somewhat camphoraceous odor, boiling at 68.2-68.7° C. and having a specific gravity of 0.732 at 15.6°C. Its properties have been, as yet, very little investigated.

Chlorination Products of Isopropyl Alcohol. The chlorination of isopropyl alcohol gives rise to a series of chlorpropanes and chloracetones, as well as traces of other compounds. The former, mainly 1, 2 and 2, 2 dichlorpropanes, are of value as non-inflammable solvents, boiling at 97-98° C. and 69.7° C. respectively. Protracted chlorination of the chloracetones gives mainly pentachloracetone, a substance capable of yielding a number of interesting and valuable products by various synthetic reactions.

Acetone is obtained by the catalytic oxidation of isopropyl alcohol, in good yield. In times of acetone shortage, this method will supplement the existing ones to good advantage.

Isopropyl Esters of formic, butyric, valeric, benzoic and salicylic acids have been made and may find application in the perfume and essence industry.

Isopropyl Aniline and the *Isopropyl Toluidines* have been prepared and undoubtedly will be useful as dye intermediates.

There are, of course, scores of other derivatives of isopropyl alcohol which may, in one way or another, prove valuable.

It is not often that one is able to record the entrance into the chemical industries of a basic substance having such wide possibilities as has isopropyl alcohol.

THE EFFECT OF HEATING COCCULUS INDICUS IN RELATION TO CHEMICAL IDENTIFICATION OF PICROTOXIN.*

By D. S. KABAYAO.

Being familiar with the practice of fish poisoning in the Philippines, by means of the roasted berries of "Lagtang" (Cocculus Indicus; Anamirta Cocculus) the active principle of which is picrotoxin, I undertook to perform a series of experiments on the process of extraction and various means of manipulation, to find whether or not the chemical tests for the detection of picrotoxin would hold good under different tests from the medico-legal standpoint, as well as the significance of the practice of preparation of the fish poison and its bearing on chemical and poisonous properties.

It may be of interest to have stated here the process formerly in common but illegal use in procuring fish by "Lagtang" poisoning. The berries (kernels) are roasted in some suitable container over a fire, the object of which is apparently to facilitate pulverization. The roasting results in browning of the kernels similar to roasted coffee. The roasted and finely ground "Lagtang" is mixed with meat or other material also finely ground and the mixture thrown into streams or into sea water. The fish, poisoned by eating this material, are gathered and used for food. It is interesting to note that people eating such fish are rarely poisoned, at any rate such possibilities have not deterred the continuation of such a practice.

The extraction of the berries for this study was made by a modified Stass-Otto method as follows:

1. *Preparation of the Material.*—A handful of the kernels placed in a nickel crucible was roasted over a free flame. The roasted berries were then ground in much the same way as is coffee.

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2. *Extraction.*—To this crude material was added acidified water (tartaric acid being used) and then the mixture was boiled for ten to fifteen minutes; it was then filtered and the filtrate evaporated to a paste.

3. *Removal of Salts, Proteins, Fats.*—To the evaporated solution, alcohol (95 per cent.) was added to extract the toxic portion. Filtered.

4. *Removal of Resins, Fats, Etc.*—The alcoholic solution was diluted with an equal volume of water. This precipitated resins and fats. The filtrate was evaporated to near dryness to remove the alcohol. The filtrate was allowed to evaporate to about two-thirds of the original volume and cooled. On cooling, white, prismatic, needle-shaped crystals were formed. Two cubic centimeters of the aqueous solution were injected into the dorsal lymph sac of a frog and the typical picture of picrotoxin convulsions was obtained.

Using commercial picrotoxin as a control, the Langley brick-red color reaction test [1] for the detection of picrotoxin was performed. About 1 mg. of both picrotoxin and the extracted substance were separately tested for the Langley reaction. The poison extracted from the roasted berries gave a negative reaction. Picrotoxin [2] reduced Fehling solution while the extracted berry poison did not.

Another experiment was conducted using the drying oven (104° C.) for drying the berries. The method outlined above was used for extraction. After having secured the extracted crystals, Langley's reaction test was performed using picrotoxin as control. Each gave a positive reaction. Both the aqueous solution of the extracted poison and commercial picrotoxin gave similar physiologic reactions in the frog. Fehling's reduction test was positive in both commercial picrotoxin and the substance extracted from the cocculus. Suspecting the changes above described to be due to the heating of the berries, similar experiments were performed on commercial picrotoxin using the paraffin bath for regulating the temperature. The melting point [3] of picrotoxin is given as 203° C. It was heated above its melting point but not enough to char the substance. It became deep

[1] *Am. Jour. Med. Sciences and Arts*, 1862, xxxiv (Series II), 109.
[2] *Am. Jour. Med. Sciences and Arts*, 1862, xxxiv (Series II), 109.
[3] *U. S. Dispensatory*, 18th Ed. 1899, 1031.

red in color and was of resinous consistency on cooling. Extraction was made, using acohol as the solvent; then the solution was decolorized with animal charcoal and set aside till crystals formed. Injection of an aqueous solution of these crystals into the frog produced typical picrotoxin convulsions. Langley's test reaction was negative as was also the Fehling's reduction test.

Something must be responsible for this change in the chemical reactivity of picrotoxin as indicated by the negative Langley reaction and a negative Fehling reduction test when heated to about 300° C. Picrotoxin dissolved in 20 per cent. sodium hydrate and precipitated by concentrated hydrochloric acid, does not answer the Langley tests, but still retains its toxic principle.[4] It is possible that the action of heat is similar in chemical changes produced. To determine whether or not oxidation was the factor causing changes in chemical properties subsequent to heat or action of chemical agents, heating was done in an atmosphere of hydrogen. The results were the same, indicating an intramolecular rearrangement due to heating at a high temperature and not likely due to oxygen of the air causing oxidative changes.

The significance of this method of preparation of the fish poison and its bearing on chemical and poisonous properties is evident, for as practiced in the Philippines, picrotoxin poisoning may occur by eating the fish poisoned with the drug, which having been heated fails to give positive reactions to the chemical tests.

Owing to great uncertainty as to the chemical structure of picrotoxin,[5] the type of action produced by heat or chemical agencies in changing the chemical characteristics cannot be more than hypothetically stated.

CONCLUSION.

In view of the experiments above described the commonly recognized chemical tests for the identification of picrotoxin (of anamirta cocculus) cannot be depended upon when, as is the custom, the berries have been roasted over a free flame. Such a preparatory roasting of the substance in some way changes the chemical charac-

[4] *Am. Jour. Med. Sciences and Arts*, 1862, xxxiv (Series II), 109.

[5] *Arch. exp. Path. u. Pharmak.*, 1911, lxiv, 407; *Zent, Bloch. Bioph.*, 1912, xiv, 827; Abderhalden, *Biochemisches Handlexikon*, Band vii, 254.

teristics without any certain diminution or alteration of its toxic properties.

In closing I wish to express my gratefulness to Dr. A. L. Tatum, of this department, under whose direction this work was performed.

BOTANICAL SOURCE OF THE COLA NUT OF COMMERCE.

By O. A. FARWELL.

I. H. Burkill, in "Notes on Cola Trees in the Economic Garden, Singapore," in *The Gardens' Bulletin* II, 74-86, Fig. 1, 1918, gives a history of the Cola trees in the garden, where they were introduced in 1879, their growth and production. He adopts the nomenclature of Chevalier and Perrot as expounded by them in *"Vegetaux utiles de l'Afrique tropicale francaise,"* VI, 1911. They claim that the *Sterculia acuminata* Beauv. of Benin is a small bushy tree seven or eight feet in height and does not produce the Kola Nut of Sierre Leone, which is the Kola of commerce, or but a very small part of it; that the tree that produces the larger part of the Kola Nut of Sierre Leone is forty feet in height and is the *Sterculia nitida* Vent. The former produces Kola Nuts with three or more cotyledons and the latter those with only two cotyledons. Under the genus *Cola* these species are known respectively as *Cola acuminata* (Beauv.) Schott and Endl. and *Cola nitida* (Vent.) Schott and Endl. Three varieties of the latter are given: var. *alba,* var. *rubra* and var. *mixta.* The fruit and seeds are illustrated and fully described. The active principles and chemical composition are given and elaborate notes on the trade, cost of drugs and chemicals during the war, cultivation and yields and properties.

Bichea Stokes Bot. Mat. Med. 2: 564, 1812, is the oldest generic name for these species and therefore *Sterculia nitida* Vent. Jard. Malm. sub. t. 91, 1804, should be *Bichea nitida* (Vent.), Farwel, n. comb.

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OSYRIS ALBA SUBSTITUTE FOR SCOPARIUS, N. F.

By Oliver Atkins Farwell.*

Some eight or nine years ago this European member of the Sandalwood family made its appearance on the American drug market under the name of Broom Tops. It is again cropping up. It bears a strong general resembance to the official drug and will easily pass muster for it either as a substitute or as an adulterant. Both are of about the same shade of green when fresh, but Scoparius fades dark brownish green, while Osyris is usually of a pale brownish or yellowish green. The branches are leafless and flowerless, but occasionally have a few berries. The larger branches or stems are evenly many striate instead of five-winged and the small branchlets about nine-angled, but none of the angles sufficiently prominent to be called winged. In Scoparius the buds are placed in the channels between the wings while in Osyris the angle begins at the middle of the bud, forming a keel on its dorsal side and runs down the stem; the bud thus appears to be on the angles instead of in the channels as in Scoparius. The larger branches and likewise the smaller are about of the same thickness and length as the corresponding ones of Broom Tops. The wood and the ground drug are white and the latter is very readily distinguishable by color from ground Broom Tops, which is of a yellowish color. A careful inspection of the crude drug, however, should at once detect this adulterant or substitute by the following characters: (1) the stems are many striate instead of five-angled or winged; (2) the buds are at the apex of an angle, which forms a keel on the dorsal side of the bud, instead of in the channels between the angles; (3) the wood is white instead of yellowish.

FOOD FROM THE AIR.†

By Henry Leffmann, A. M., M. D.‡

It is a primary principle of biology that plants are intermediate between animals and the earth. It is the plant that works up the

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†Abstract of a lecture delivered as one of a series of popular lectures at the Philadelphia College of Pharmacy and Science.

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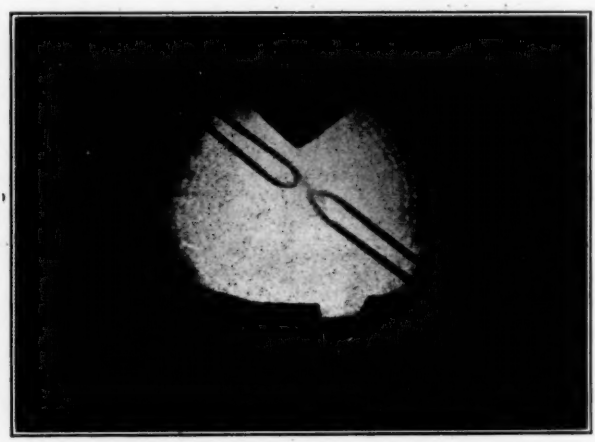
inorganic materials, carbon dioxide, water, phosphates and nitrates, into new forms, principally proteins and carbohydrates upon which herbivorous animals feed, convert into other substances, and become in turn the food of carnivorous animals. After death, all organisms are converted into inorganic materials and the cycle of rebuilding is resumed.

It is obvious, therefore, that the maintaining of human life is absolutely dependent on the maintaining of vegetable life, so that in the last analysis, the land is the only source of wealth. The last hundred years have witnessed an enormous growth of population,



Arc of the Birkeland-Eyde Furnace. From *Trans. Farad. Soc.*, 1906, **2**, 98. *Courtesy of the Wagner Free Institute of Science.*

and its concentration in cities at an increasing ratio. The area of land under cultivation has not increased in the ratio of the increase of those dependent on it, who are so placed that they cannot increase food production. Although some of the advance in the cost of meat and dairy products is due to trust-control, aided by methods of cold storage, both for withholding perishable articles and facilitating transportation to other countries, these conditions are not alone to blame. There is a real *relative* scarcity.

High fertility of land depends on the presence of certain classes of inorganic substances and on certain types of living organisms. While much remains to be determined as to the best conditions of plant growth, it is now pretty well established that the plants which

form the food of man and of the herbivorous animals eaten by him, require compounds of phosphorus, potassium and nitrogen. A few of the compounds of these elements are especially adapted for plant growth, and it is the endeavor of the agriculturist to obtain soils containing these substances, or to add them if lacking. Phosphates and potassium compounds are found in many parts of the world, but the supply of nitrogen compounds is not so widely distributed, and so far as nitrates are concerned, which are the best forms for plant nourishment, the world has been for some time relying on deposits on the west coast of South America, commonly known as the

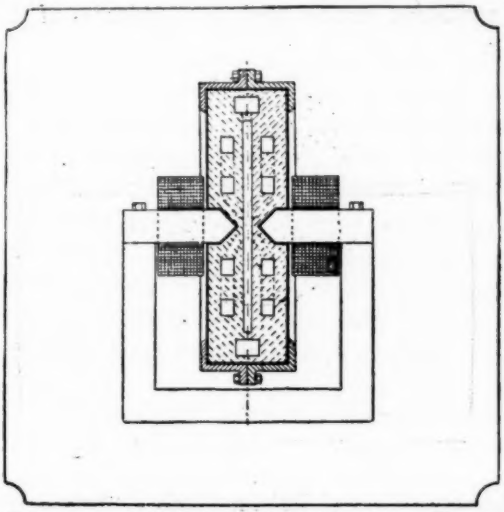


Diagram of Birkeland-Eyde Furnace. *Trans. Farad. Soc.*, 1906, **2**, 98. *Courtesy of the Wagner Free Institute of Science.*

"Chili nitrates." These deposits are extensive, but not inexhaustible, and experts have been active of late to secure a source of nitrogen in form fit for plant life that may render the world independent of local deposits. Not only is this question related to plant life, but many important products of modern industry depend on nitric acid and ammonia, and it is desirable to safeguard these industries against a lack of raw material. Dye-stuffs, many medicinal substances and most high explosives require for their production nitric acid.

The great and practically inexhaustible supply of nitrogen is the atmosphere, which contains about four-fifths its volume of the ele-

ment, but it is in the free state, and, under ordinary conditions, free nitrogen is very difficult to bring into combination. Under some natural conditions, a utilization of nitrogen occurs that has much value in farming, but no application to the industrial question. Many plants of the bean family,—clover, for instance,—develop upon their roots minute tubercles, which are found to be accumulations of bacteria, that convert nitrogen into compounds that the plant can take up. Thus, a mutual relation is established, termed "symbiosis," which has been practically applied to increasing the fertility of soils. It has long been known that clover plowed in increases the productive power of a soil. The reason is known, and benefit results from inoculating certain seeds with cultures of these bacilli before planting.

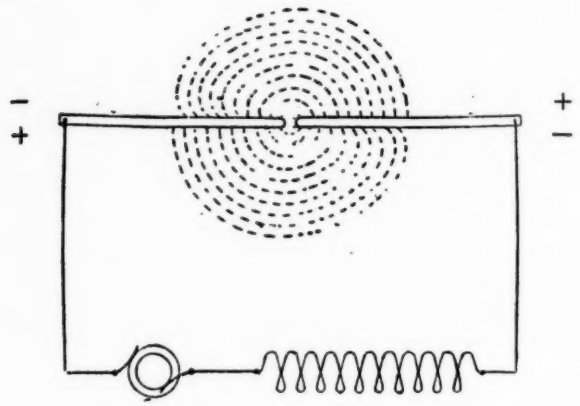


Diagram of Arc of Birkeland-Eyde Furnace. *Trans. Farad. Soc.*, 1906, **2**, 98. *Courtesy of the Wagner Free Institute of Science.*

For the industrial conversion of the free nitrogen of the air into compounds, several methods have been devised. The procedure is called "fixation."

Fixation of Nitrogen by Oxidation.—The simplest method in principle for converting nitrogen into useful compounds is direct union with the oxygen in mixture with it in the air, but this is impossible as far as known under ordinary conditions. The affinities of both elements are too low. Under the influence of high tension electric discharges oxygen acquires a much higher affinity, though only a very small percentage of the total volume is affected. These

effects were noted in the eighteenth century by Cavendish and Priestley. Methods of producing electricity were long imperfect and expensive, but the modern methods are capable of application on a commercial scale and installations for the production of nitrogen oxides, especially nitric acid, have been made in several places. The installation is essentially that of an arc lamp with the carbons so arranged that a flaming discharge is produced. One of the successful forms is the Birkeland-Eyde furnace, which uses an alternating current of high voltage surrounded by a constant magnetic field. This magnetic influence spreads out the arc in a fan-shape so that it may be six feet in diameter. A plant of this type was operated about twenty years ago at Niagara Falls. Under ordinary commercial conditions the cost of sodium nitrate from Chili is such as make it not profitable in this country to use such a process. Other forms involving the same general principles have been invented and operated. Notwithstanding the simplicity of the principles on which the electric current acts, the practical operation involves difficulties. The temperature must be carefully regulated, as the reaction is of the class called "reversible," that is, under certain conditions the compounds will be decomposed as fast as formed. Where water-power is available, the process can be worked with success. The action of the arc, however, is not entirely due to its heat.

Fixation of Nitrogen by Absorption.—Calcium carbide produced by the action of finely divided carbon upon lime, under the influence of the electric arc, has been a commercial product for many years for the manufacture of acetylene. When it is heated strongly in a current of nitrogen, direct combination takes place, with the formation of calcium cyanamide and some free carbon. Calcium cyanamide can be used directly as a fertilizer, and as it contains slightly more nitrogen in proportion to weight than sodium nitrate, it has been much used. In the manufacture of calcium cyanamide precautions must be observed to avoid dangerous explosions, but these need not be detailed here.

In the case of the union of nitrogen and oxygen under the influence of the arc, the action is what is called "endothermic," which means that it is attended by the absorption of heat, but the formation of cyanamide is an "exothermic" reaction, *i. e.*, attended by the giving out of heat, and care must be taken that the mass does not

become too hot or the nitrogen will be driven out. Calcium cyanamide has been marketed under the trade name "nitrolin." The cyanamide process requires nitrogen in a fairly pure state, but in the direct-arc process the raw material is air, which is in unlimited supply. The fertilizing properties of the cyanamide are due largely to its ready conversion into ammonia under the influence of moisture and the bacteria of the soil. A large plant for the production of this substance was erected by the United States Government at Muscle Shoals, Alabama, during the late war.

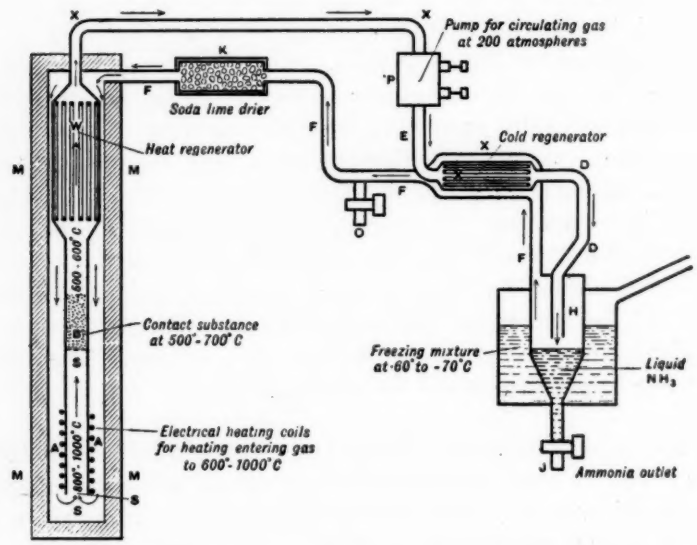

Pump for circulating gas at 200 atmospheres
Soda lime drier
Heat regenerator
Cold regenerator
Contact substance at 500°-700° C
Freezing mixture at -60° to -70°C
Liquid NH_3
Electrical heating coils for heating entering gas to 600°-1000°C
Ammonia outlet

Diagram of Haber-Le Rossignol Installation. Martin and Barbour, Industrial Nitrogen Compounds, 54. *Courtesy of the Wagner Free Institute of Science.*

Fixation of Nitrogen as Ammonia.—Many sources of ammonium compounds exist. They are produced in the putrefaction and destructive distillation of organic materials. As these cases do not come within the scope of fixation of atmospheric nitrogen they will not be further considered. Ammonium compounds can be transformed into many other nitrogen compounds including nitric acid, hence their production is desirable, and a great deal of attention has been given to the utilization of the immense stores of nitrogen in the atmosphere. The process that has been most extensively applied is

that in which hydrogen and nitrogen are compressed at high temperatures in strong cylinders. It is generally called the "Haber process," from the name of the principal inventor who lately received the Nobel prize for his work in this line. The name of Le Rossignol is also associated with it, as the two published in 1913 a paper on the subject which marks the beginning of the application. The pressures and temperatures required are very high, which renders the procedure somewhat dangerous. The German chemists, who have most extensively employed the method, resorted to the expedient of sinking the cylinders in the ground as additional strengthening. The combination of the two gases cannot be brought about by mere contact under any pressure or temperature. It is found that a third substance is required, but this need be present in only small amount and does not take permanent part in the action, so that it can be used repeatedly. This kind of action, of which many examples are now known, in which a substance acts by its presence, is termed catalysis and the substance is termed a "catalyst." The inventors found the number of substances available as catalysts in this process to be quite limited, and one of the most active to be very rare and expensive. They found, however, that certain uranium compounds would act. On the basis of their work, the Germans constructed a large plant for the manufacture of ammonia and the conversion of it into other important nitrogen compounds. As large amounts of heat and power are not required the process is capable of exploitation in many parts of the world. It has, however, found its most extensive development in Germany, to which it was of immense service during the war. From information obtained since the close of the war, it seems probable that if the Germans had not had this method in active and extensive operation, they would have been obliged to suspend the war early in 1915, as the supply of Chili nitrates would have been cut off by the British blockade. They were able, however, to secure within their own territory all the nitric acid needed for the manufacture of dyes and munitions.

The main German installation was at Oppau near Ludwigshafen on the Rhine, operated by the Badische Anilin and Soda Fabrik. It appears from investigations made by an American officer that during the year preceding the signing of the armistice, this plant had fixed 90,000 tons of nitrogen, and that in 1916 the entire German

equipment fixed 400,000 tons. The cost of the Oppau plant was over $25,000,000.

In 1921 a terrible explosion occurred at this plant by which many persons were killed and part of the plant and nearby houses wrecked. The cause of the explosion has remained in doubt. It is, indeed, not likely that the German chemists, even if they knew the cause, would take the world into their confidence.

The United States, during the war, started a small plant to manufacture nitrogen compounds by this method, but it seems that it did not get beyond the experimental stage. It was located at Muscle Shoals, Alabama, with the cyanamide plant.

Other processes for nitrogen fixation have been devised, among which is that of Bucher, in which air is passed over coal or coke mixed with an alkali and with finely divided iron as a catalyst. A cyanide is formed, which by simple methods may be converted into other nitrogen compounds.

There seems to be no doubt that the United States should establish at once a large plant for nitrogen fixation by some approved process, in order that we may be independent of the Chili supply, which apart from the possibility of its exhaustion, might be cut off from us in case of war.

ABSTRACTED AND REPRINTED ARTICLES

RECENT ADVANCES IN PLANT CHEMISTRY.*†

[Abstract]

By R. W. THATCHER.§

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The study of the chemistry of plant life is one of the most recent phases of the development of the science of chemistry. Economic interests have always stimulated metallurgical research and

*Reprinted from the *Jour. Ind. and Eng. Chem.*, April, 1922.

†Presented before the Rochester Section of the American Chemical Society, Geneva, N. Y., October 1, 1921.

§Director of Experiment Station.

studies in connection with processes of industrial manufacture of organic compounds. Interest in pubic health problems has been a powerful stimulus to the study of the chemistry of physiological and pathological processes of animal life. But similar studies of the chemistry of plant life have been, for the most part, left to the botanists or to an occasional biochemist who has had as his impelling motive a keen interest in the works of Nature as manifested in the growth of plants. Even so-called "agricultural chemists" have devoted most of their energies to the problems of supplying anergic foods to plants in the form of fertilizers, or to the problems of animal nutrition, or to the inspection service in connection with the regulation of the sale of agricultural products to or from their ultimate consumer.

Recently, however, there has appeared in the plans and the writings of a few biochemists the idea that the study of the synthetic activities of plants offers a fascinating and fruitful field both for scientific inquiry and for economic development.

Undoubtedly the most serious handicap which biochemists have had in their attempts to study or duplicate the chemical processes which take place in cell protoplasm lies in the fact that they have thus far been compelled to work with mixtures of reagents in solution, contained in beakers, test tubes, etc., in which ionization and diffusion make a uniform chemical change throughout the entire reacting mass practically unavoidable. Recent advances in our knowledge of the colloidal condition make it plain, however, than even in so small a mass as the protoplasmic contents of a single cell there are thousands, if not millions, of colloidal compartments, separated from each other by membranes of variable and perhaps constantly varying permeability, in which a great variety of chemical changes may go on independently of each other.

It seems to be, therefore, that the first requisite for up-to-date study of the chemistry of living things is a recognition of the *structure* of the cell as an essential factor in its synthetic operations, and that the first advancement toward an understanding of and possible duplication of the cell synthesis will require the successful reproduction of a colloidal mass having similar structure to that of cell protoplasm.

A proper mental picture of the organization and activity of

a plant cell is suggested by the figure of a well-organized chemical factory, with the different transformations which are involved in the whole process going on in different parts or rooms of the factory, with the raw materials systematically transported from one room to another as they are needed to keep each step in the whole process going at the proper rate; and with all the different parts of the whole factory working in smooth co-ordination with each other.

The raw materials for this factory are the mineral matter and water coming from the soil and the gases of the atmosphere; the intermediates are the simple carbohydrates and amino acids; and the finished products comprise all of the varied compounds which are the results of cell protoplasmic activity and which are used by the plant for its nutrition, growth or reproduction.

The researches of botantists and chemists in the past have dealt with the nature of the compounds and the chemical changes which are involved in each separate process of the factory's operation. The principal problem now is to learn the nature and method of superintendence of the factory whereby its operations are automatically regulated and altered so as to provide the proper output of all the varying products of the factory to meet the needs of the whole plant. We are as yet almost wholly in the dark concerning the regulatory agencies which control the rate and character of the synthetic processes of cell operation. We call these regulatory agents catalysts, or enzymes, but as to what they are and how they act we know very little.

Furthermore, we have absolutely no idea of the methods of intercommunication and of recognition of supplies and needs of raw materials or finished products whereby the factory output is varied in kind or quantity to meet the needs of the growing plant. We say, more or less empirically, that "hormones" stimulate certain cell activities. But what are hormones, and how do they happen to be in the right place and at the right time to start the factory operation as it is needed? We speak glibly of "inhibitors" which slow up or stop any given process when its products accumulate in quantities unsuitable for the proper functioning of the plant organism; but we know little of their nature or origin.

In my opinion, therefore, the most significant contributions to our knowledge of the chemistry of plant life in recent years are those which deal with the phenomena associated with the colloidal conditions of matter and with the catalysts, stimulants, and inhibitors which serve to regulate both the direction and the velocity of the chemical reactions which, taken as a whole, constitute the vital phenomena.

I regard as one of the most promising fields of investigation of plant chemistry the apparently simple, but as yet little understood, relation of water to the colloidal condition of organic materials. The recent preparation of an artificial gel which is so nearly solid that it can be cut into blocks with a knife and from which no water can be squeezed out, which yet contains less than 0.3 per cent. of solid matter, is an illuminating example of the possibilities of almost infinite dispersion and of the extent to which surface boundary phenomena may be brought into play in semisolid colloidal masses like that of plant protoplasm. The constant changes in concentration of dissolved solids by colloidal imbibition of water, and the protection of protoplasm against injury by extreme changes of temperature, as well as the adaptation of plant protoplasm to its environmental surroundings are all definite chemical phenomena which may well find their explanation in the water relations of the colloidal mass.

A further aspect of plant chemistry, the significance of which is easily apparent from the simile of the factory, is that chemical changes which are almost the exact antithesis of each other are going on simultaneously in every active plant organism, if not indeed in each individual plant cell. The synthetic production of complex organic compounds and the destructive oxidation of previously produced synergic foods to furnish energy for the synthetic processes go on simultaneously; just as, in any factory, there is consumption of fuel, wearing out of equipment, etc., during the process of manufacture of the factory output. This phenomenon, too, is readily understood on the basis of colloidal structure and emphasizes again the importance of recognition of this condition of matter as a necessary step in studies of protoplasmic activities.

IMPROVED METHOD FOR THE PREPARATION OF VITAMINE-ACTIVATED FULLER'S EARTH.*

By ATHERTON SEIDELL,

Technical Assistant, United States Public Health Service.

Since the discovery several years ago [1] that certain varieties of fuller's earth, particularly the variety from Surrey, England, exert a remarkable adsorptive power for the antineuritic vitamine, this reagent has been exclusively used as the first step in my attempts to isolate vitamine from brewer's yeast. For this purpose the fresh yeast was allowed to autolyze, and the resulting product was filtered. Fuller's earth was then added to the clear liquid and, after thorough agitation, the solid was removed by filtration and was washed and dried. The "activated fuller's earth" thus prepared, on account of its relative uniformity and exceptional stability, was believed to be the most favorable raw material for experiments on the isolation of the antineuritic vitamine.

The most unsatisfactory step in the process of preparing "activated solid" is the extremely slow and wasteful filtration of the autolyzed yeast. Numerous experiments were early made for the purpose of eliminating this very troublesome filtration, but improvements worthy of recommendation were not developed. Recently, however, by making use of an observtion of Osborne and Wakeman,[2] a substantial improvement in the method has been made and is now brought to the attention of persons interested in the more precise study of the chemical and physiological properties of the antineuritic vitamine.

It was demonstrated by Osborne and Wakeman that when fresh yeast is added to boiling water, acidified with 0.01 per cent. acetic acid, the yeast cells are disrupted, the protein is coagulated, and the vitamine is set free to enter the aqueous solution. This latter can readily be separated from the coagulated protein and insoluble material and is a very much more satisfactory solution for the adsorption of vitamine by fuller's earth than the very complex filtrate from autolyzed yeast.

*Reprinted from *Public Health Reports*, April, 1922.

[1] Seidell: *Public Health Reports*, 31, 364 (1916).

[2] Osborne and Wakeman: *Jour. Biol. Chem.*, 40, 383 (1919).

The advantages resulting from this modification are that the manipulations are greatly shortened and simplified and, what is of greater importance, a much better final product is obtained. The basis of the latter claim is that at least one of the interfering substances simultaneously adsorbed with the vitamine is almost, if not entirely, eliminated. This compound is adenine, which is a product of the autolysis and is present in the yeast filtrate and subsequently adsorbed by the fuller's earth. It is, however, not formed to an appreciable extent during the rapid heating of the fresh yeast according to the modified method, and consequently does not become an impurity in the final "activated solid."

The improved method for preparing vitamine-activated fuller's earth on a moderately large scale has been very satisfactorily carried out as follows:

Fresh bottom yeast, as obtained from the brewery, in quantities of 50 or more liters, is diluted with about an equal volume of tap water and heated, while being stirred, in a steam-jacketed kettle until the temperature reaches approximately 90° C. It has been found that if this temperature is exceeded, the mixture is apt to foam excessively and overflow the kettle. After about five minutes at 90°, the mixture is cooled to 50° or less, and the coagulated protein is removed by filtration.

The protein can be very effectively and expeditiously removed by means of a large Sharpless centrifuge. The protein remaining in the bowl of this machine is of cheeselike consistency and retains a relatively small proportion of the aqueous vitamine solution. This latter is a clear dark-brown liquid. English fuller's earth is added to it in the proportion of 30 grams per liter and the mixture is actively stirred for one-half hour or longer. It is then subjected to filtration or the solid may be removed more conveniently by means of the Sharpless centrifuge. The "activated solid" is finally washed with several changes of water and alcohol and then thoroughly dried to prevent subsequent growth of molds, which are very readily nourished by the minute amounts of organic material from the yeast solution, persistently retained by the "activated solid."

Samples of "activated solid" prepared by the above process were found to contain approximately 1.5 per cent. of nitrogen instead of slightly more than the 2 per cent. usually present in samples prepared by the original method from autolyzed yeast filtrate. The

content of antineuritic vitamine, as estimated by feeding experiments on pigeons, was found to be about twice as great as that of the product made by the original method. Complete protection of pigeons against loss in weight on a diet of polished rice, or restoration of such lost weight, was afforded in all cases by doses of 0.1 gram on alternate days. Doses of 0.05 gram prevented all but a very slight diminution in weight for many weeks.

From these tests it is evident that the protective dose for pigeons of 300 grams weight is under 0.1 gram; whereas with samples of "activated solid," prepared by the original method, adequate protection usually required doses between 0.1 and 0.2 gram. This, taken in connection with the lower nitrogen content and absence of adenine is ample evidence of the greatly improved character of the "activated solid" prepared by the new method.

PRODUCTION OF CASTOR OIL IN ARGENTINA.*

Trade Commissioner GEO. S. BRADY, compiled from a report prepared by Carlos D. Girola for the Argentine Minister of Agriculture.

Castor oil is prepared from the seed of the "tartago" or castor-oil plant which has been grown in northern Argentina for many years. While the plant grows as far south as the 40th parallel, its practical cultivation is limited to that part north of the 30th parallel. From 3000 to 4000 hectares (1 hectare equals 2.47 acres) are cultivated each year, distributed approximately as follows among the Provinces and Territories: Chaco Territory, about 2000 hectares; Entre Rios, 1000 hectares; Corrientes and Tucuman, each less than 500 hectares; while there are small quantities produced in Misiones, Formosa, Salta, Sante Fe and Santiago del Estero.

The variety cultivated in Argentina is designated as "ricino colorado" or red castor bean (*Ricinus sanguineus*). In the Chaco Territory the seed is sown in August, and ripens within four to six months after the planting. Calculations are based on a production of one metric ton (one metric ton equals 2204.6 pounds) of seed per hectare, but a crop of two tons is often produced, and a yield as

*Through *Commerce Reports,* of these changes modifies the principles upon which the proposed method rests.

high as three tons per hectare has been recorded in the Chaco. According to an analysis made by the Argentine Department of Agriculture the castor bean grown near Resistencia, Chaco, yielded 52 per cent. of oil.

COMMERCIAL OIL PRODUCTION.

There are five important factories in Argentina producing castor oil and several other vegetable-oil factories that manufacture it on occasion. In these factories the oil is extracted both by the cold and the hot process. The product is used both medicinally and industrially. Prices for the 1920-21 crop of castor beans ranged from 14 to 18 pesos per kilo, husked (the peso at that time approximated $0.36 United States currency; the kilo equals 2.2 pounds). The production of castor oil in Argentina is estimated to be between 1,000,000 and 1,250,000 liters (one liter equals 1.05 quarts), all of which is consumed locally. The importation of medicinal castor oil was reduced from 401,660 kilos in 1913 to 116,856 kilos in 1919. Up to the present the castor-oil cake has found no application except as fuel since fertilizers are not ordinarily used in Argentina. The cake has been selling at about 12 pesos per metric ton.

There is an extensive territory in Argentina well adapted to the cultivation of the castor-oil plant, and the farmers of the northern part of Argentina are ready to produce more of the seed if there is a larger market. The oil manufacturers also claim to be able to produce a much greater quantity of castor oil if the market warrants it.

A PLEA FOR THE METRIC SYSTEM.*

For years the problem of introducing the metric system into general use in this country has occupied the interest of physicians as well as of other scientists. This system is today employed in all the civilized world except Great Britain and her colonies, Russia and the United States. Even Russia, before the outbreak of the war, calculated all her imports according to the metric system. The present time seems to be distinctly opportune for a renewed agita-

*From the *Journ. Amer. Med. Assoc.*

tion in the United States for adopting the system. Two million American soldiers received some instruction in its use during their sojourn in France; many of our industrial plants became familiar with the metric scale through work on war material designated for shipment abroad, and the wiping out of international borders is today more closely realized than ever before in the world's history. At its last meeting, a committee of the American Chemical Society recommended the general adoption of the metric scale and requested that chemists hereafter order all supplies in metric quantities. A resolution favoring the method was introduced into the House of Delegates of the American Medical Association, at the Boston session. As one hears of the numerous organizations cited as being wholly favorable to discarding the old methods and to replacing them by the metric, one wonders how it is that the change has not long since been made. The medical profession should take the lead and not follow in this reform. If it is to do this, the first step must be education of the young men. Teachers in medical colleges should teach in terms of the metric system and talk in terms of the metric system at the bedside as well as in the lecture room. To stop at this, however, would be slow work. It is necessary that medical journals, too, should feel their responsibility in this matter. If authors who submit manuscripts do not give measurements in metric terms, the periodicals may aid the movement by making the necessary transposition.

SCIENTIFIC AND TECHNICAL ABSTRACTS

X-Ray Opaque Meal.—Two types of preparation are used in the X-ray examination of the stomach and digestive system, the one, "bismuth milk," in which the salt of bismuth is in suspension in a mucilaginous solution, and the other, "the opaque meal," a semi-solid mixture of the bismuth or barium salt with a suitable food. The essential properties of the opaque meal are, that it should be easy to make, have a pleasant taste, and be perfectly innocuous. The authors have used for some years an "emulsion powder" as a base

for bismuth or barium meals. The formula is that of the French Pharmacopœia, as follows:

Sweet almonds	30	gms.
Bitter almonds	2	gms.
White sugar	30	gms.
Powdered gum tragacanth	0.5	gm.
Orange flower water	10.0	gms.
Water	120	gms.

With regard to the particular opaque substance employed, bismuth carbonate neutralizes more or less the gastric juices, whilst barium sulphate tends to hasten the evacuation of the bowels. Bismuth-subnitrate was abandoned as the cause of a number of accidents. It is very important that whatever salt is employed it should be in a high state of purity.—(M. D'Halluin and D. Raquet [*Arch. d'électric. med.*, 1921, 29, 105, through *Pharm. Journ. and Pharm.*, 1922, p. 264].)

A Color Reaction Common to Antiscorbutic Extracts and to Hydroquinone.—The author has succeeded, by modifying Folin's phenol reagent, in evolving a color reaction for vitamin C. His formula is:

Sodium tungstate	100	gms.
Phosphomolybdic acid	20	gms.
Concentrated phosphoric acid	17	c.c.
Water ..... to	1000	c.c.

To this is added an equal quantity of normal sulphuric acid. It is not to be boiled. Unlike Folin's reagent, this does not give a reaction with a variety of organic compounds. It gives a slate-gray color turning to blue with the juices of certain fruits and vegetables the antiscorbutic properties of which are well known (*e. g.*, grapes, tomatoes, cabbage, etc.). Barley, turnips, etc., which are useless in scurvy, give no reaction. Cabbage juice which has been subjected to prolonged boiling loses its positive reaction. The juice of a potato extracted in the presence of an acid gives a positive reaction, but if the acid is omitted or is added subsequently no reaction is obtained. The urine of a man whose diet contains a good proportion of antiscorbutic agents gives a positive reaction. Tried with a variety of phenol compounds, negative results were obtained, except in the case of hydroquinone, which gives a sharp blue reaction.—(N. Bezssonoff [*Compt. rend.*, 1921, 173, 466, through *Pharm. Journ. and Pharm.*, 1922, p. 264].)

American Potash Industry.—Potash is one of the essentials of the American chemical industry, entering as it does so largely into the manufacture of fertilizers. Previous to the war the United States imported 200,000 tons annually. When this supply was cut off in 1905 the chemical industry responded and increased the American production from 1000 tons in 1915 to 54,000 tons in 1918, and poured money into the project until by the end of 1920 the investment represented $28,696,000. Today practically all these plants are shut down, and would-be American producers find that they cannot sell a pound of potash on the American market at any price, owing to the German contracts with the fertilizer manufacturers. A close study of the facts, according to *Chemical and Metallurgical Engineering,* "has convinced us that the American potash industry is deserving of the sink or swim chance which the proposed tariff will afford it" This tariff, for which forty-five potash manufacturers are petitioning Congress, calls for a sliding scale duty on potash imports for five years, at the end of which time potash will go on the free list.

"The war has taught us the value of several key industries, and a surprising proportion of these were our basic chemical industries. Potash proved to be one of those essential commodities, the supply of which we suddeny found was lacking from our industrial make-up, Now that, by long and tedious experimenting and costly research, we have developed the makings of a creditable potash industry, are we going to permit it to thrive or to die? The price to be paid for this domestic industry is insignificant in comparision with its value to chemistry in America. It is scarcely necessary to urge the chemical industries to lend their support to the potash tariff. If our entire chemical independence could but be purchased by the adoption of such moderate rates of duty, we would indeed have cause for rejoicing." The policy of disarmament should not be extended to American industry.—(Through *Industrial Digest.*)

A New Source of Santonin.—Arno Viehoever and Ruth G. Capen. As a result of a survey of American plants it is evident that santonin can be obtained from *Artemisia mexicana* and *Artemisia neo-mexicana,* which grow wild in Mexico, New Mexico and neighboring states.

The survey thus far made comprises seventeen species and plant material obtained from thirty different sources. The santonin isolated was identified by the form and refractive indexes of the crystals, the melting point, furfural reaction, and the formation of santonin periodide.

Though no quantitative data are as yet on hand, the manufacture of santonin now quoted at $150 per pound, from domestic sources, appears a distinct possibility.—(Contribution from the Pharmacognosy Laboratory, Bureau of Chemistry, Dept. of Agriculture.)

A NEW HYDROGEN PROCESS.—Much attention has been paid of late years to methods of obtaining hydrogen, principally on account of its use in the treatment of fats and for the inflating of dirigibles. It has also some applications as a reducing agent and as fuel. The use of ferrosilicon in solution of sodium hydroxide is one of more recent methods, which is described in a paper by E. R. Weaver, presented at the forty-first meeting of the American Electrochemical Society in April last. Although more expensive than other processes, it is suitable for military use on account of the small cost of the plant and the simplicity of operation. The reaction is between the silicon and the alkali, and the principal equation is

$$2NaHO + Si + H_2O = Na_2SiO_3 + 2H_2.$$

This represents the change at the beginning of the operation, but secondary reactions occur by the hydrolysis of the sodium silicate. The temperature must be controlled during the process. The facts that none of the materials used is combustible, that they do not give off any gas until mixed and are easily transportable, are especially advantageous in naval operations. The gas produced is of high purity, traces of phosphine and acetylene being the principal impurities, although hydrocarbons and even arsine may occur. The disposal of the exhausted liquor is, however, a serious matter, as it is too alkaline to be thrown into a running stream.

H. L.

GENUINE ATTAR OF ROSES THREATENED WITH EXTINCTION.—Roses are yielding to tobacco in Bulgaria. The valley districts which lie at the foot of the Balkans produce more attar of roses than any other region in the world. But unless a check can be placed on a mysterious disease which has recently attacked the rose

bushes there, the fragrant oil will become so costly that very few will be able to afford the luxury of the genuine odor. Many of the rose growers of Bulgaria have become alarmed at the inroads of the disease which threatens their property and their livelihood and have taken up the raising of tobacco instead.

The Bulgarian attar of roses is of a very fine quality, and sells for nearly $125 a pound wholesale in the European markets. In diluted form it is sold as perfume in the shops of Paris and London for five times its wholesale price. The fragrance of two thousand pounds of distilled rose petals is in each pound of the genuine attar. Cheaper perfumes are made artificially, but connoisseurs claim that there is a distinction in the scent and that the artificial variety is not so lasting.—(*Science Service.*)

NEWS ITEMS AND PERSONAL NOTES

PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE NOTES.

Robert C. White, nationally known as an expert adviser in matters pertaining to manufacturing pharmacy, is the most recent addition to the College Faculty. He is Instructor in Manufacturing Pharmacy.

On Friday Evening, April 4th, at the City Club, members of the Commercial Department conferred on publicity for next year's courses for retail druggists. The course which is designed looks to a practical and comprehensive survey of Commercial science as adapted to the exact needs of retail pharmacy. Professor Cook is in charge of this Department.

Professors Cook and Sturmer recently attended the pleasant ceremony of pyro-martyrdom of the mortgage of the New York College of Pharmacy, not the first time that the destructive distillation of cellulose afforded a reason for ceremonials.

The re-election of Dr. Braisted as President of the College is eminently pleasing to the student body which has collectively learned

to love and to respect Dr. Braisted, whose pleasing personality and devotion to the college cause has won him the admiration of all who come in contact with him.

Ivor Griffith, Editor of the AMERICAN JOURNAL OF PHARMACY and Physiological Chemist to the Stetson Hospital, repeated his One Drop of Blood lecture before the Philadelphia Microscopic Society, at the Wagner Institute of Science, evening of April the 11th, and again, on May 15th, at the Commencement Exercises of the same institution.

Professor Heber W. Youngken has been re-elected editor of the section of Pharmaceutical Botany and Pharmacognosy by the Board of Control of Botanical Abstracts. This is an honor that has successively come to Professor Youngken for a number of years.

Dr. Paul S. Pittenger, Physiological Chemist of the Mulford Laboratories and Professor of Physiological Chemistry at the College, delivered a lecture on the physiological testing of drugs, at the New Jersey College of Pharmacy, Newark, N. J. on March 17th.

The various methods for ascertaining the physiological effect of potent drugs were demonstrated, and revealed the inadequacy of chemical standardization to secure uniformity of therapeutic action.

In addition to the regular student body the demonstration was attended by a large number of physicians and pharmacists who seemed to appreciate the practical application of physiological testing in advanced pharmacy.

President Braisted, with all his activities, finds time to carry the story of the college and its ambitious program to fields never thought of before. For instance, he was recently the principal speaker at a reception of the Kiwanis Club, then before the Art Club and later at the Bellevue-Stratford at a dinner tendered by the Medical Societies of Philadelphia in honor of Dr. De Schweinitz.

A few days ago the Fisherman fareth forth and spendeth full many an hour in the sea-village of Longport. Bountifully equipped and with a Q. S. of the "hope that springs eternal" he looked to a

full basket—when lo, he returneth with a basket void of any "ancient and fish-like smells" but with "tales of diverse wonderful escapes of exceeding many and great Fyshes." He is none other than the Dean of the College.

The Annual Dance of the Kappa Psi Fraternity was held at the Belfield Country Club evening of Monday, March 27th. It was an exceedingly successful affair, well attended and put through with the finesse and eclat that generally graces the functions of the College Chapter of this old and honorable fraternity.